THE UNIVERSITY OF ALBERTA

THE DRUMMING SITES AND DRUMMING ACTIVITY OF TERRITORIAL RUFFED GROUSE IN SOUTHWESTERN ALBERTA

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, A thesis entitled "The Drumming Sites and Drumming Activity of Territorial Ruffed Grouse in Southwestern Alberta", submitted by Kenneth Michael Sumanik in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

The characteristics of the habitat used by territorial ruffed grouse in southwestern Alberta were examined by recording the kinds and numbers of woody stemmed vegetation found within 131 drumming sites used by these birds. Extensive variation between drumming sites in regard to density and size of trees suggest that ruffed grouse are unable to select for these characteristics; nor do they select for any combination of deciduous and coniferous trees. Eighty-four per cent of the drumming sites possessed totalled cover class values between four and six inclusive, thus they occurred in areas where the cover was both mixed and incomplete. Adult males occurred more frequently on drumming sites which possessed a deciduous cover class value of three than did immature males. Shrubbery produced canopy covers ranging from 0 to 50 per cent. Diameters of 117 drumming logs ranged from 7 to 24 inches, the average being 13 inches. Approximately 75 per cent of these logs lay between 70 degrees S. of W. and 28 degrees N. of W. Three-sixteenths of a mile was the average distance over which drumming sounds were heard. Drumming activity in 1965 began in late April, reached a "peak" during early May,then ceased by late June. Fluctuations in drumming activity seem to be related to changes in light intensity, temperature, wind and precipitation. Changes in the rate of drumming suggest that drumming sounds have a stimulative effect on territorial ruffed grouse. The rate of drumming is maximum during the period of peak drumming activity.

An estimated 24 territorial ruffed grouse occurred on the West area in 1964 and 1965. Using the Petraborg method there was a 30 per cent over estimate of the territorial ruffed grouse population on the West area. Twenty-six males were shot on this area subsequent to the period of peak drumming activity. Reoccupation occurred in three of the vacated territories. The ratio of immature to adult males was 2-6 to 1.

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INTRODUCTION

The ruffed grouse (*Bonasa umbellus*) is a very important native upland game bird. An insight into the regulation of the numbers of this bird is important, particularly for management purposes, and in the understanding of its ecology in general.

This study investigated several aspects of the ecology of the ruffed grouse in the foothills region of southwestern Alberta: the habitat used by territorial male grouse; the changes in drumming activity throughout the breeding season and the affects of physical and biotic factors on drumming activity. An examination of past methods of censusing male ruffed grouse was undertaken and a new method of estimating populations was developed.

Field research was conducted during the spring and summer, late April to mid-September inclusive, in 1964 and 1965.

Study Area

The field research for this study was conducted in the foothills along the eastern edge of the Rocky Mountains in southwestern Alberta. This region is part of the Bow River Forest in the Alberta Forest Reserve. Headquarters were established at the R. B. Miller Biological Station situated in the Sheep River Valley approximately 21 miles WSW of Turner Valley, Alberta.

The study area was divided into eastern, western and

northwestern sections which are referred to as the East, West and Northwest study areas. Figure 1 shows the location of these areas.

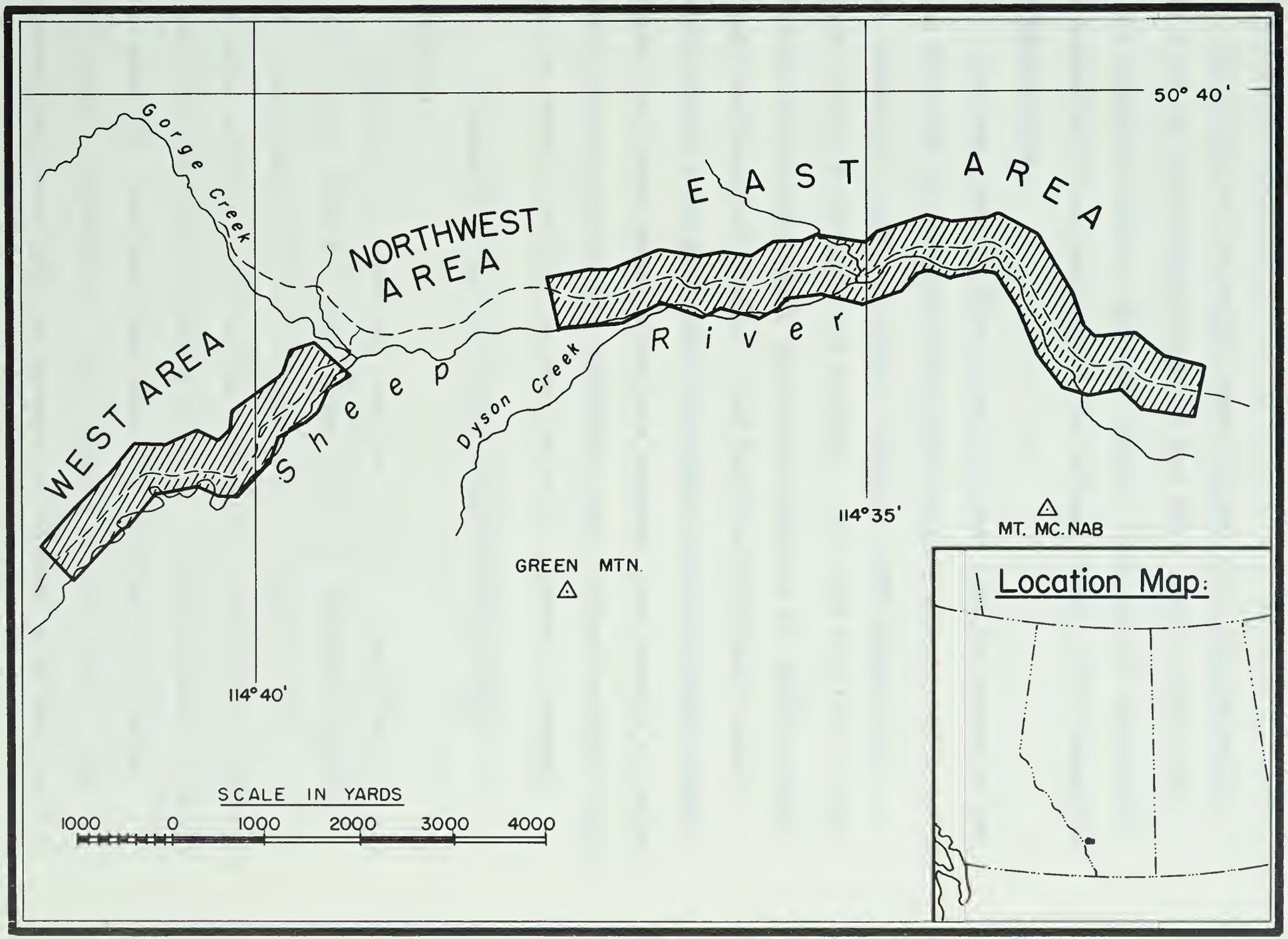
A forestry access road extends along the north bank of the Sheep River and bisects the East and West areas. Mile post markers exist along this read, numbering the miles from the eastern border of the forest reserve. The easternmost edge of the East area begins at approximately mile 4-1/2 and ends at mile 8. The easternmost edge of the West Area begins at approximately mile 9-3/4 and ends at mile 12-1/2. Local headquarters of the Alberta Forest Service are situated between the East and West areas.

The total area of the East study area, 962 acres, was calculated from the length of the road and the width on either side over which drumming sounds could be heard. The area of the West Area, 608 acres, was calculated in a similar manner.

The Northwest study area extends WNW from the confluence of Gorge and Deadhorse Creeks. It is bounded by Gorge Creek to the South and West, a forestry fire trail - the North Fork Truck Trail to the North and Northeast, the gate to the fire trail to the east and a narrow strip of land between Gorge Creek and the North Fork Truck Trail to the Northwest.

Other grouse species occur in this region. Franklin's grouse (*Canachites canadensis franklinii*) inhabit the extensive pine and spruce stands; blue grouse (*Dendragopus obscurus richardsonii*) inhibit the steep slopes and ridgetops. White tailed ptarmigan (*Lagoupus leucurus*) are found in the areas

Figure 1. Location of the study areas in the Sheep River Valley. Density of male ruffed grouse estimated within the shaded portions of the East and West areas.


50° 40'
Gorge Creek
NORTHWEST AREA
EAST AREA
WEST AREA
Sheep River
Dyson Creek
114°35'
MT. MC. NAB
GREEN MTN.
114°40'
Location Map:
SCALE IN YARDS
1000 0 1000 2000 3000 4000

above tree line.

Altitude on the study areas ranged from approximately 4200 feet at the eastern edge of the East area to 5500 feet at the western edge of the West area. Hage (1943) described the topography and geology of the areas; Boag (1964) described the vegetation.

The East area differs from the West and Northwest areas in as much as it possesses many open grassy slopes and benches, pure stands of trembling aspen (*Populus tremuloides*) and several steep hillsides and ravines. In 1964 and 1965, these portions of the East area were not inhabited by ruffed grouse during the breeding season. The West and Northwest areas possess fewer ravines, steep hillsides and pure aspen stands. However, on these areas there are several pure stands of white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*) which were not used by ruffed grouse during the breeding season.

CHARACTERISTICS OF RUFFED GROUSE TERRITORIES

Introduction

According to Odum and Kuenzler (1965) a territory is all or part of an animal's home range which is defended against other individuals of the same species. Pitelka (1959) considers territoriality as an ecological phenomenon, important in partitioning the available habitat. Stenger-Weeden (1965), in a study of tree sparrows (*Spizella arborea*) in Alaska, added another dimension to the concept of territory. She suggests that territory is dynamic in nature in as much as it

varies with changes in the behaviour of the inhabitant. These changes are of two sorts: (1) changes in the territorial activity during a single day; and (2) changes in territory size with the various stages of the breeding cycle.

The most common activity of ruffed grouse which takes place in territories is a periodic wing-flapping which results in a series of "thumping" or "drumming" sounds. These sounds are essentially an auditory threat which functions as a means of territorial defense. Female ruffed grouse do not drum.

The drumming act is usually performed at one location along a log or any other elevated object serving as a drumming platform. This location is called the centre of the drumming site. The drumming log and all vegetation within an arbitrary 15 foot radius of this focal point constitutes the drumming site.

Unlike some other grouse species such as black grouse (*Lyrurus tetrix*),sharptailed grouse (*Pedioecetes phasianellus*), sage grouse (*Centrocercus urophasianus*) or other typical "lekking" grouse - territorial ruffed grouse infrequently associate with other territorial ruffed grouse. This reduced interaction may be the main reason that territory boundaries of ruffed grouse are less well defined than those of "lekking" grouse. In a study of the black grouse, Hjorth (pers. comm.) found that territorial black grouse actively defend a specific area on the breeding grounds. These grouse delimit their territories by using certain tussocks, hummocks, low shrubs,

rocks or sticks as "markers" along their territory boundaries. He added that even during periods of intense interaction, only very minor changes occur in territory size. It is difficult to determine accurately the boundaries of a ruffed grouse territory because drumming activity usually occurs at more than one site and because males are rarely observed actively maintaining a specific boundary. However, territory, in this discussion, refers to the area enclosed by straight lines joining the outermost drumming sites used by a ruffed grouse. Within a territory, there are certain sections which are used more frequently than others. These specific areas, which occur in the immediate vicinity of the most commonly used drumming sites, are referred to as the primary activity centers.

Occasionally, the drumming logs which occur on each site are used by more than one ruffed grouse. Marshall (1965) reported that, with the approach of spring, a male ruffed grouse regularly visited ten known drumming logs of which four were occupied by established males. This male then initially occupied an area which was partially used by another male ruffed grouse. Having once established a territory, the area of activity of this grouse was reduced from approximately 80 to 10 acres.

Eng (1959), in a study of male ruffed grouse in Minnesota, recorded the distance of grouse moved from their drumming logs. Maximum distances moved occurred in winter; minimum distances moved occurred in spring. Movement during the breeding season was restricted since territorial ruffed grouse activities were

centred in the vicinity of the most frequently used drumming sites. Marshall (1965) described the area of activity of a territorial ruffed grouse in Minnesota. He found that the area used by territorial ruffed grouse changed seasonally with maximum and minimum areas used occurring in winter and spring respectively. Eng (1959 , p. 102) stated that "adult males, once they had become established as drumming birds, spent the rest of their life in a relatively restricted area". He also noted that most juvenile males established territories in the vicinity of drumming logs which they had used during the period of fall drumming. Thus, it appears that once a ruffed grouse occupies a certain territory it continues to use this territory for the duration of its life.

Extensive descriptions have been made of the habitat used by ruffed grouse along their range in the United States. In a study of the cover requirements of ruffed grouse in Iowa, Polderboer (1942, p. 53) stated that "forest types of prime importance are, in order: *Populus* consociations, 10-20 year old oak-hickory and 5-10 year old clearings. Advanced oak-hickory and 20-35 year old second growth oak-hickory rank high enough in availability to be considered as valuable cover". He did not state whether certain of these forest types used by ruffed grouse possess conifers. In a study of ruffed grouse in New York, Bump *et al*. (1947) discovered that areas lacking sufficient conifers did not maintain good grouse populations. Although they suggested that a mixed forest type generally provided good grouse habitat they did not describe

the nature of this forest. It was Edminster (1947) who, working in the same area, arbitrarily decided that conifers should constitute at least 20 per cent of this mixed forest type habitat. Frank (1947) described the habitat used by ruffed grouse in west-central Connecticut. He stated (p. 307) that "of the timber types present, hardwoods (mainly the oak ridge type) occupy 47 per cent of the area; swamp hardwoods, 22 per cent; coniferous plantations 17 per cent; and miscellaneous types, 14 per cent". In a study of ruffed grouse in Wisconsin, Dorney (1959) evaluated specific forest types and the extent of their use by ruffed grouse during each season of the year. He concluded (p. 29) that in spring, Wisconsin ruffed grouse were "distributed equally throughout all forest types, with the exception of open or unforested land .... and were not as strongly dependent on conifers for winter shelter as is the case in New York, based on comparative studies". Hungerford (1951) attempted to determine the type of cover used by ruffed grouse in the cut over forest lands of northern Idaho. He reported low correlations in the various cover types used by ruffed grouse. In a further attempt to explain the occurrence of ruffed grouse in assorted habitat, Hungerford correlated various microclimatic zones with their use by ruffed grouse. He concluded (p. 224) that, "generally the grouse choose the warmest sites in winter, the warmest roosting sites at night in summer and the coolest spot to rest during a warm summer day".

In a study of ruffed grouse in eastern and central Canada, Clarke (1936, p. 47) stated that "ruffed grouse did not inhabit:

(1) unbroken forest of any type; (2) grazed woodlots; (3) purely coniferous brush; (4) areas of solid brush without trees or open spaces; (5) brules where the second growth poplar or conifers had not yet reached roughly twenty feet in height, unless a considerable residue of the original forest is left".

Territory maps drawn by Clarke (*Ibid*) indicated that territorial ruffed grouse generally occurred in a mixed hardwood forest. Some coniferous vegetation occurred in this forest. Polderboer (1942) reported that drumming did not occur in any specific cover type. However, other researchers have suspected that some relationship does exist between vegetation type and drumming site use. Frank (1947 , p. 310) stated "drumming sites observed .... were usually in dense cover, frequently coniferous, but within a radius of two to three feet around the spot where a bird stands, there was little or no vegetation". Of the vegetative factors measured on 46 drumming sites Eng (1959 , p. 103) found that "tree density was the most variable, shrub cover next and overhead cover, which was often a combination of the other two factors, was the least variable". Dorney (1959) reported that his findings supported Eng's research. Palmer (1961), following a detailed analysis of vegetation on and off drumming sites in Northern Michigan, was unable to isolate any single factor responsible for governing the extent of drumming site use. In a study of Minnesota ruffed grouse, Gullion *et al*. (1962, p. 622) stated that "locations of 139 logs used between 1956 and 1961 indicate heavy preference for shrubby cover and low preference

for closed canopy stands".

Generally, research thus far suggests that the characteristics of drumming logs are less variable than the vegetative characteristics. Polderboer (1942 , p. 53) found that "the presence of a log more than 7 feet long and 10 to 24 inches in diameter seemed to be the prime essential". Similar views are shared by Bump *et al.* (1947), Edminster (1947), Palmer (1961) and this author. In some regions ruffed grouse may use other objects than logs as drumming platforms. Frank (1947) reported that stone walls, boulders and rock out-crops were used more frequently than logs. Gullion *et al.* (1962 , p. 618) stated that a drumming site is "normally an elevated object or drumming log, which is commonly a fallen log but may also be a rock, mound of dirt, decumbent trunk of a living tree, root of a standing or fallen tree, a stump or even a snow bank in the spring".

One of the objectives of this study was to examine the physical and vegetative features of drumming sites and to determine the relationship between these features and the degree of drumming site utilization.

Methods

Location of ruffed grouse territories

A crude delineation of territory was undertaken by determining the number and location of drumming sites used by each territorial ruffed grouse. These drumming sites were located by following to their source, the drumming sounds

produced by naturally or artificially marked ruffed grouse. Natural markings included colour phase, damaged plumage and behavioural patterns; artificial markings consisted of coloured plastic bands combined with a single aluminum band placed on the legs of trapped ruffed grouse. The birds were caught in mirror traps described by Gullion (1964). To prevent desertion from their drumming sites the birds had to be handled carefully. A dark cloth was placed over the cage containing the trapped bird, the drumming site restored to its natural state and the bird removed 75 to 100 yards from the place of capture before release.

Only those sites observed being used were recorded. It is possible that the grouse may have used more sites than those which were recorded. Therefore, those sites on which ruffed grouse were repeatedly seen were only assumed to be the main drumming activity centres. I believe, however, that most of the drumming sites used by the birds were located.

Because it was not possible to determine territory boundaries precisely, size comparisons of territories were not feasible.

Vegetation analysis

One of the characteristics of a ruffed grouse territory is the vegetation surrounding the centre of drumming activity. An evaluation of the kinds and number of woody stems and the resultant canopy coverage was conducted at each drumming site. Woody vegetation within the site was tallied according to the number of stems, diameter at breast height (d.b.h.) and canopy

coverage for each species. Diameter at breast height was measured in centimeters. The following classification was employed: 1->0 to 2 cm; 2->2 to 5 cm; 3->5 to 10 cm; 4->10 to 15 cm; 5->15 cm. Canopy coverage was estimated by vertical projection of the outermost branches of each tree species. The estimated coverage was ranked according to the following percentage classification: 1->0 to 5; 2->5 to 25; 3->25 to 50; 4->50 to 75; 5->75 to 95; 6->95 to 100. Because the branches of any one species may overlap the branches of another it is possible for the total coverage for all species to exceed 100 per cent. The ratio of the maximum coverage values of the deciduous to coniferous trees on each site was also recorded.

Characteristics of the drumming platform

Another characteristic of the drumming site is the type of drumming platform. Ruffed grouse on the study area seldom used anything other than logs for drumming. However, two large exposed roots served as drumming platforms for two birds.

The diameter, direction and species of each drumming log were recorded. The diameter of the drumming log was measured at the most frequently used location. The direction was recorded as true North by subtracting 23 degrees, the compass deviation, from all magnetic readings. Direction was taken from crown to butt.

Each drumming log, provided it was not too badly decomposed, was classified according to species. Colour of the rotten woody material was used to differentiate between coniferous and deciduous logs; the woody material in coniferous logs is rust

or straw coloured whereas in deciduous logs it is white or buff coloured. Coniferous logs were differentiated by using diameter measurements and, wherever possible, by locating the cones. Coniferous logs greater than 15 inches in diameter were regarded as white spruce; mature lodgepole pines on the study area seldom exceed this diameter. Coniferous logs occurring in moist low-lying areas were regarded as white spruce; those in drier upland areas were regarded as lodgepole pine. Using the texture or appearance of the log surface as a guide, deciduous logs were recognized as being aspen or black poplar. Aspen logs without bark possess a smooth surface. Black poplars with bark possess a rough multifaceted surface. Without bark these trees display a smooth multifaceted surface.

Results

Number of drumming sites

Table I presents the number of drumming sites per territory, as well as the total number of territories occurring on the study areas. These data strongly indicate that ruffed grouse territories include more than one drumming site; approximately 70 per cent of the territories possessed more than one site.

Vegetative features of drumming sites

One of the major features of the drumming site is the associated vegetative cover. In southwestern Alberta, ruffed grouse generally occur in the mixed forest. This habitat type consists primarily of poplars (*Populus tremuloides*, and *P.*

Table I. The number of Drumming Sites Per Territory on the East, West and Northwest Areas, 1964 and 1965.

Year	West Area No. of Drumming Sites Per Territory					Total	Northwest Area No. of Drumming Sites Per Territory					Total	East Area No. of Drumming Sites Per Territory					Total
	1	2	3	4	> 4		1	2	3	4	4		1	2	3	4	> 4	
1964	9	7	4	4	0	24	0	2	0	1	0	3	No Data					
1965	5	14	3	1	1	24	0	1	3	1	0	5	3	2	5	1	0	11*
% of Total	29.2	43.7	14.6	10.4	2.1		0	37.5	37.5	25.0	0		27.2	18.2	45.6	9.0	0	

* Two territories not located; two other located but number of drumming sites per territory not known, thus there was a total of 15 territories on the East area in 1965

balsamifera), white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*) in the forest canopy. Numerous shrubs also occur in the mixed forest. The following shrubs, in order of abundance, occurred within the drumming sites: willow (*Salix spp.*); rose (*Rosa woodsii* and *R. acicularis*); buffaloberry (*Shepherdia canadensis*); gooseberry (*Ribes oxyacanthoides* and *R. lacustre*); raspberry (*Rubus strigosus*); juniper (*Juniperus horizontalis* and *J. communis*); bearberry (*Arctostphylos uva-ursi*); cinquefoil (*Potentilla fruticosa*); birch (*Betula glandulosa*); snowberry (*Symphoricarpos occidentalis*) and alder (*Alnus crispa*). These shrubs compose the forest understory.

In Table II, the number of each species of tree occurring on the drumming sites is classified according to d.b.h.

Within the drumming sites, deciduous trees outnumbered coniferous trees by approximately three to one, except for the greater than 15 cm. diameter classes, in the relative numbers of deciduous and coniferous trees. Seventy per cent of the trees were 5 cm. or less in diameter indicating an abundance of young trees within the drumming sites. Only one per cent of the trees were greater than 15 cm. in diameter. This scarcity of large trees within the drumming sites reflects the young nature of the trees which occured with the drumming sites. Except for the 0 to 2 and greater than 5 cm. deciduous diameter classes, the standard deviation exceeded the mean. The extensive variation between drumming sites in regard to the density and the size of the

Table II. Distribution of Diameter Classes of Trees on 131 Drumming Sites in 1964 and 1965.

Diameter (cm.)	Number of Trees		% of Total Trees		Mean No. of Trees Per Drumming Site and Std. Deviation			
	Deciduous	Coniferous	Deciduous	Coniferous	Deciduous		Coniferous	
					Mean	SD	Mean	SD
0-2	1668	607	19.8 (*25.6)	7.2 (31.6)	12.7 ±	14.4	4.6 ±	6.6
2-5	2847	775	33.8 (43.7)	9.2 (40.4)	21.7 ±	16.8	5.9 ±	10.8
5-10	1626	410	19.3 (24.9)	4.9 (21.4)	12.4 ±	7.4	3.1 ±	5.2
10-15	329	84	3.9 (5.1)	0.9 (4.4)	2.5 ±	2.8	0.6 ±	1.6
>15	44	43	0.5 (0.7)	0.5 (2.2)	0.3 ±	0.8	0.3 ±	0.8
	6514	1919	77.3 (100.0)	27.7 (100.0)				

* Numbers in parenthesis represent the percentage of deciduous and coniferous trees in each diameter class.

trees suggests that territorial ruffed grouse do not select for these characteristics on their drumming sites. Nor do they select for any combination of deciduous and coniferous trees.

Another factor, the canopy coverage afforded by the trees within each drumming site, was estimated and arranged according to a broad scale. The number of drumming sites in each deciduous to coniferous cover class is presented in Figure 2. Drumming sites were not found in every combination of deciduous to coniferous class. Sites did not occur where deciduous coverage was lacking completely; nor did they occur where deciduous cover was 100 per cent. Some 8.4 per cent of the sites did not possess coniferous coverage.

The frequency with which deciduous and coniferous cover class values were found to occur are presented in Figure 3. The most common coniferous cover class value was 1. Deciduous and coniferous cover class values were combined, resulting in a scale of values ranging from a minimum of 0 to a maximum of 12. The results are presented in Table III. Any site with a total cover class value of 0 would be void of cover; a site with a value of 12 would have 100 per cent deciduous and coniferous coverage. Approximately 85 per cent of the sites possessed total cover class values of between 4 and 6 inclusive. Thus, it appears that the drumming sites occurred in areas of the forest where the cover was both mixed and incomplete.

The shrubbery within the drumming sites was not uniformly layered; it usually occurred as isolated clumps of varying

Figure 2. Distribution of drumming sites in relation to varying cover class ratios of deciduous and coniferous vegetation.

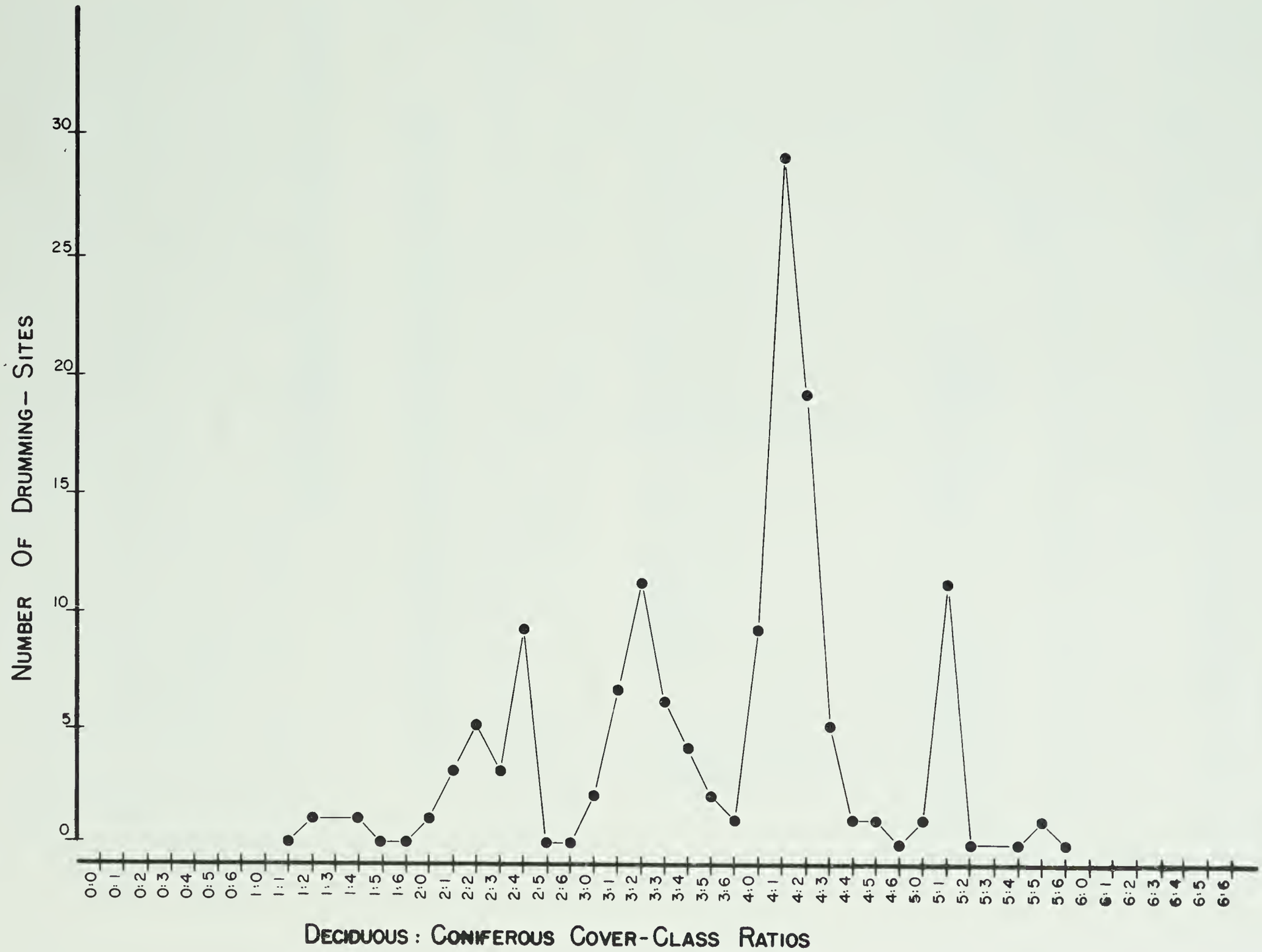

NUMBER OF DRUMMING-SITES
30
25
20
15
10
5
0
0:0 0:1 0:2 0:3 0:4 0:5 0:6 1:0 1:1 1:2 1:3 1:4 1:5 1:6 2:0 2:1 2:2 2:3 2:4 2:5 2:6 3:0 3:1 3:2 3:3 3:4 3:5 3:6 4:0 4:1 4:2 4:3 4:4 4:5 4:6 5:0 5:1 5:2 5:3 5:4 5:5 5:6 6:0 6:1 6:2 6:3 6:4 6:5 6:6
DECIDUOUS : CONIFEROUS COVER-CLASS RATIOS

Figure 3. Percentage of drumming sites in each deciduous and coniferous cover class.

height. The canopy coverage produced by the shrubbery ranged from 0 to 50 per cent, with most sites possessing less than 5 per cent coverage.

Table III. Percentage of Drumming Sites in Each Coverage Class.

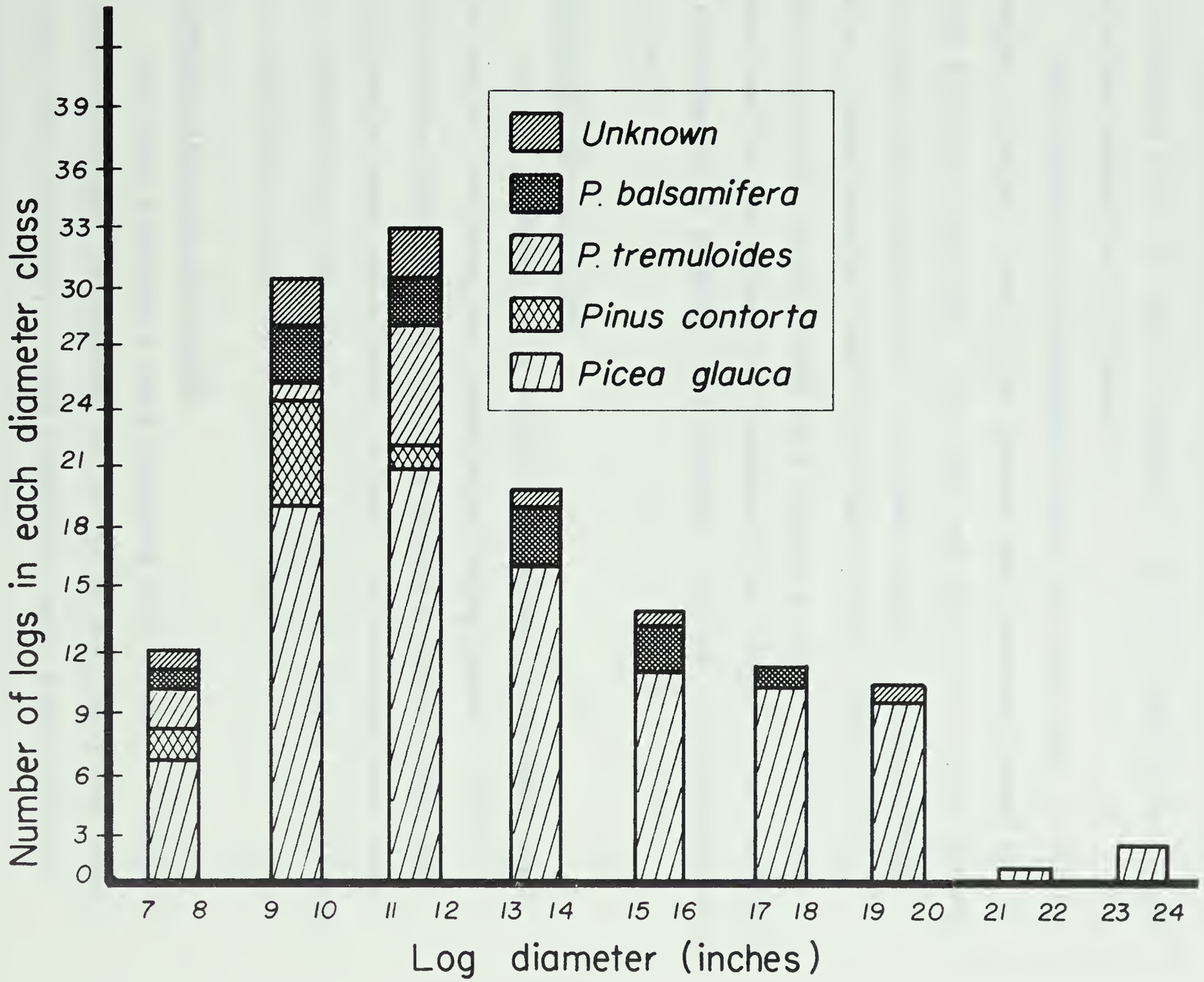
Coverage class values*	Number of drumming sites	Percentage of drumming sites
0	0	0
1	0	0
2	1	0.7
3	6	4.6
4	25	19.0
5	45	34.3
6	40	30.5
7	8	8.0
8	3	3.0
9	2	2.0
10	0	0
11	1	0.7
12	0	0
Total	131	100.0

*Deciduous and coniferous cover classes (1 to 6) were calculated separately and then summed.

Physical features of drumming sites

On the study area, the most commonly used drumming logs within each drumming site were, in decreasing order of occurance: white spruce, black poplar, aspen poplar and lodgepole pine. The distribution of diameter and species of drumming logs used by the ruffed grouse is presented in Figure 4. Diameters were measured to the nearest inch and ranged from 7 to 24 inches.

Figure 4. Distribution of size and species of 131 drumming logs used by ruffed grouse.


Number of logs in each diameter class
0
3
6
9
12
15
18
21
24
27
30
33
36
39
Unknown
P. balsamifera
P. tremuloides
Pinus contorta
Picea glauca
7 8
9 10
11 12
13 14
15 16
17 18
19 20
21 22
23 24
Log diameter (inches)

The average diameter was 13 inches.

Seventy-three per cent of the drumming logs lay between 70 degrees S. of W. and 29 degrees N. of W., true North. These data are summarized in Figure 5.

Two drumming logs possessed bark; the rest were in various stages of decay. Two ruffed grouse were observed drumming from exposed tree roots. One root was part of a living spruce; the other was probably part of a dead spruce. On the study area, stumps were not used by ruffed grouse. Occasionally, more than one log was found on a drumming site. If all logs were used by the grouse for drumming then the site was regarded as possessing a drumming log complex. Figure 6 illustrates such a site.

Territory use and reuse

If any drumming site within a territory was reused then the entire territory was regarded as being reused. Of 24 territories used in 1964, 20 were reused in 1965. Four new territories were established in 1965. On the Northwest area, all territories that were used in 1964 were reused in 1965 and two additional territories were established.

Drumming site use and reuse

The most frequently used drumming site within a ruffed grouse territory is referred to as the primary activity centre within that territory. Less frequently used sites are the auxillary centres.

In 1964 and 1965, 69 drumming sites were located on the

Figure 5. Distribution of the direction of 117 drumming logs used by ruffed grouse.

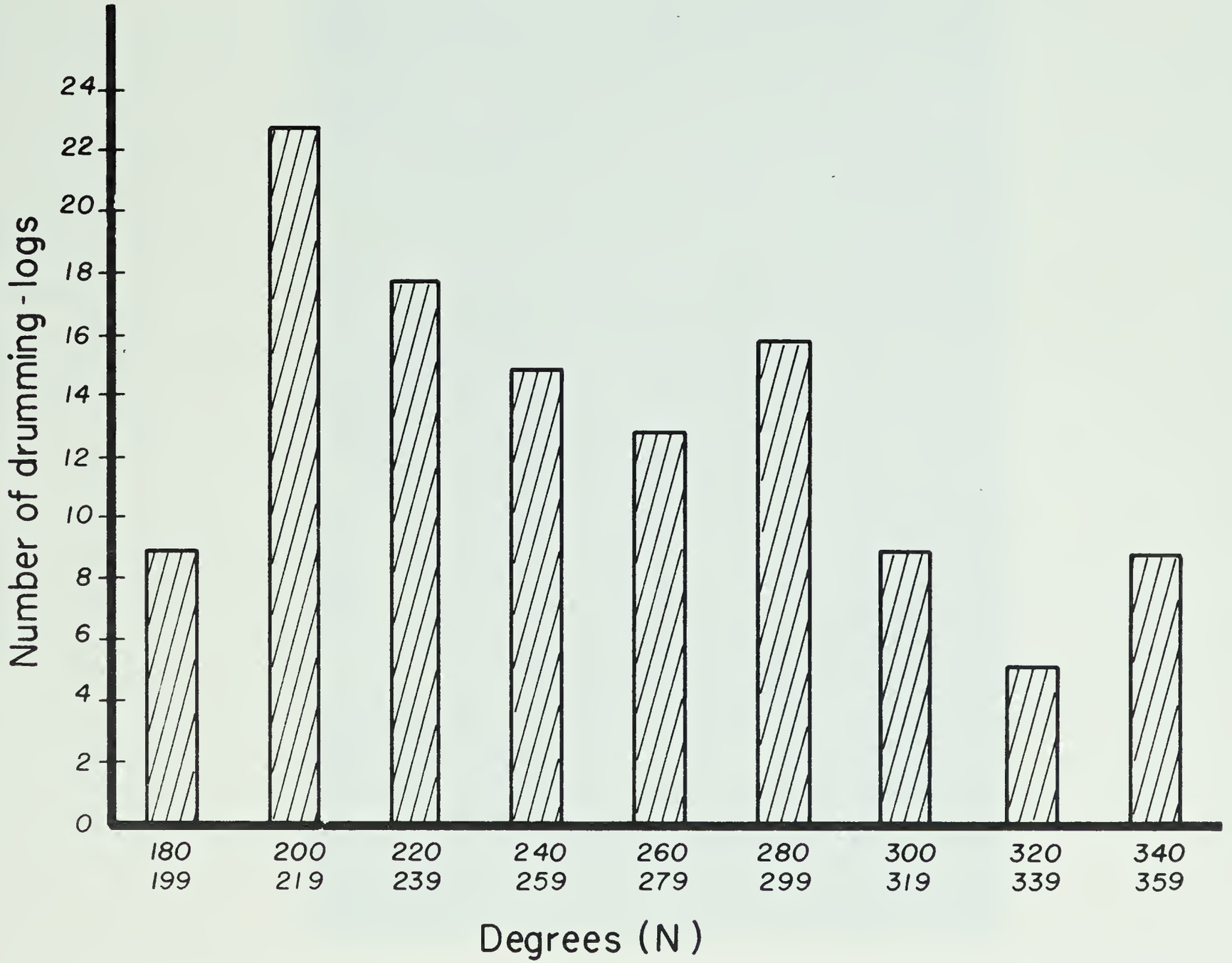

Number of drumming-logs
0
2
4
6
8
10
12
14
16
18
20
22
24
180
199
200
219
220
239
240
259
260
279
280
299
300
319
320
339
340
359
Degrees (N)

Figure 6. Drumming site possessing a complex of drumming logs.

West and Northwest areas. From Table IV, which depicts the utilization of these sites, it is apparent that the total number of drumming sites which were used remained unchanged from one year to the next.

Table V presents the degree of utilization of various drumming sites over a two year period. From these data, it is evident that drumming sites which are extensively used one year are generally in use again the following year; moderately or slightly used drumming sites are less likely to be in use the following year. Although there appears to be difference between the degree of drumming site use and subsequent reuse, this difference is not significant at the 5 per cent level. Thus, it would appear that if a log is used as a drumming site over one year, it has generally an equal chance of being used in subsequent years. However, if one compares only the number of extensively used sites with the number of extensively reused sites, the relationship becomes highly significant. If a drumming site is only moderately or slightly used in one year, it is unlikely that it will be used extensively another year. Thus, the degree of drumming site use reflects the relative "acceptability" of the site to the grouse. It follows, then, that there exist certain characteristics which determine the extent of utilization of the site by grouse.

Comparisons were made between the cover class system of the drumming sites used by adult and immature ruffed grouse. These data are presented in Table VI. Significantly ($P = <5$) adult males occurred more frequently on drumming sites which

Table IV. Utilization of Drumming Sites on the West and Northwest Areas in 1964 and 1965.

	Drumming sites in use		Drumming sites reused		
Year	West	Northwest	West	Northwest	Percentage
1964	61	8	No Data		No Data
1965	55	14	33	6	57

Table V. Degree of Drumming Site Use in 1964 and Subsequent Reuse in 1965.

	Drumming Site Utilization			
	Extensively		Moderate to Slightly	
Year	Number	Per Cent	Number	Per Cent
1964 use	26	-	43	-
1965 reuse				
Extensively	14	53.8	2	4.6
Moderate to Slightly	8	30.8	15	34.9
Not Used	4	15.4	26	60.5
		100.0		100.0

possessed a deciduous cover-class value of three than did immature males. Drumming sites with a deciduous cover class value of three generally possessed more conifers than did those having a cover class value of four or five. Figures 7 and 8 illustrate drumming sites with these cover class values.

Table VI. Deciduous Canopy Coverage on Drumming Sites Used by Adult and Immature Ruffed Grouse.

Cover Class Value	Canopy cover per cent	Drumming sites used by immature males	Drumming sites used by adult males	Total	χ^2
1	0-5	2	0	2	0.09
2	6.25	4	3	7	0.42
3	26-50	2	7	9	0.85
4	51-75	33	9	42	8.95
5	76-95	5	2	7	0.01
		46	21		11.39

Discussion

Although it was not possible to determine precisely the extent of each ruffed grouse territory, the number of drumming sites used by each ruffed grouse, probably the main components of a ruffed grouse territory, was determinable. In a study of ruffed grouse in Ontario, Bendell (pers. comm.) noted that territorial birds used up to seven drumming sites. In this study the number of drumming sites constituting a territory also ranged from one to seven; but since these data were based upon

Figure 7. Drumming site possessing a deciduous to coniferous cover class ratio of 3:4.

Figure 8. Drumming site possessing a deciduous to coniferous cover class ratio of 4:1.

direct observations of marked grouse while on their logs, it is possible that some sites have been excluded from the sample.

The number of sites used by a grouse is probably determined by the number of drumming logs available and by the nature of the vegetation in which these logs are situated. Territories used by the ruffed grouse in this study were situated in a mixed forest consisting primarily of a mixture of poplars, spruce, and pines. This forest is relatively less complex than the mixed hardwood-conifer forests of the midwestern and eastern United States and Canada.

In describing the vegetation in the immediate vicinity of drumming logs in minnesota, Gullion *et al.* (1962, p. 619) state that "drumming logs are located typically (96 out of 139) in shrubby cover with no over head forest canopy, in a forest *edge* situation, or in stands with less than 60 per cent crown closure". However, on the study areas in Alberta, approximately 84 per cent of the drumming sites possessed a canopy coverage ranging from 76 to 95 per cent. Thus, territorial ruffed grouse on the study areas occupied drumming sites with more crown closure or canopy cover than the sites in Minnesota. However, different methods of assessing canopy cover could account for this discrepancy.

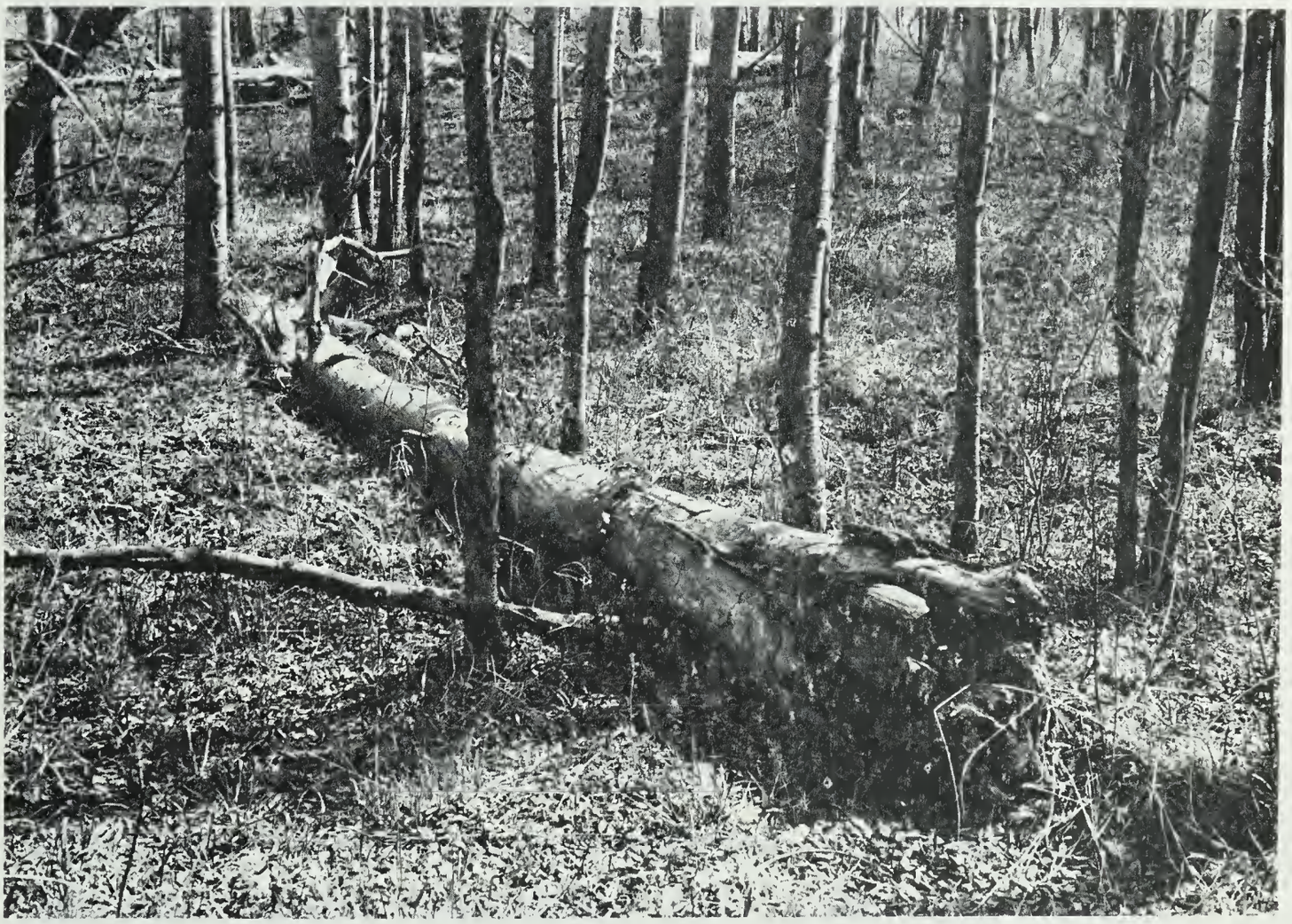
Although deciduous trees usually outnumbered coniferous trees on the drumming sites, the role of the latter may be

more important. Because deciduous foliage does not appear until late in the breeding season, conifers probably afford most of the protective cover for the grouse during the early part of the breeding season. At this time, those sites possessing 26 to 50 per cent coniferous canopy coverage would provide more secure habitat for the territorial ruffed grouse than would sites with 0 to 5 per cent coniferous canopy coverage.

Gullion *et al.* (*Ibid*) found that, in northern Minnesota, certain areas which, on the basis of topography, forest cover and the presence of logs, appeared to be suitable activity centres, were not used by territorial ruffed grouse. However, this situation did not occur on the study areas in southwestern Alberta.

Shrubbery has been regarded as an essential component of a ruffed grouse drumming site. Upon examination of the forest vegetation used by territorial ruffed grouse in Wisconsin, Dorney (1959, p. 23) found that "if there are no trees or shrubs in the one to six foot layer, breeding territories are not established". The reason for this could be that, if shrubs are absent from a drumming site, the grouse may be more vulnerable to predators. During this study, two males were found which had been killed while on their drumming sites. Both of these sites had reduced amounts of shrubbery, although the canopy coverage was adequate (Fig. 9). Shrubbery probably affords protective cover in so far as it partially obscures a territorial ruffed grouse. It may also facilitate escape by the grouse when pursued by predators. For this reason, shrubbery has often been referred to as "escape cover". Thus, the presence of shrubbery

Figure 9. Drumming site with reduced shrub cover.



within a drumming site probably increases the chances of survival of the ruffed grouse using the site.

The drumming log is another important feature of the drumming site. In a study of ruffed grouse habitat in New York, Edminster (1947, p. 33) found that "the log selected for drumming must have certain characteristics of size and conditions ... and is selected to a considerable extent on the basis of its location and soundness". Eng (1959, p. 79), on the other hand, found that drumming logs in Minnesota ranged from "very rotten pulpy logs to those which showed no signs of decay". A similar range of drumming logs was found in southwestern Alberta.

The drumming logs in this study usually occurred on level or gently sloping ground. Logs on slopes generally lay with the slope or at right angles to it. Logs occurring on steep slopes were seldom used by ruffed grouse, although one drumming log was found on a 22 degree slope. However, it was seldom used.

Drumming log diameter taken during this study approach closely those recorded by other workers. In Minnesota, Eng (1959) found that diameter ranged from 5.1 to 22 inches with a mean diameter of 12.5 inches. Palmer (1963) found that drumming logs in Michigan ranged from 7 to 21 inches in diameter with a mean diameter of 13 inches.

Ruffed grouse in this study used decaying coniferous logs seven inches in diameter or greater. The minimum size seems to be related to the need for support during the drumming performance (Edminster, 1947). During the initial stages of

drumming, the wings are thrust sharply forwards and downwards (Palmer, 1963). The actions, which tend to displace the bird backwards, are offset by extending the head forward and by occasionally using the tail as a prop. If the diameter of the log was less than seven inches the grouse would be unable to use its tail effectively as a support during the initial stages of drumming.

The direction of drumming logs in southwestern Alberta compares with those found in northern Michigan by Palmer (1963), who suggests that drumming log direction is dependent largely on the direction of the prevailing winds.

Since most of the drumming logs on the three study areas were large rotten white spruce logs, a mature white spruce forest must have existed in this region. Isolated patches of mature spruce, scattered throughout the area are probably remnants of that forest. In the poplar stands adjacent to these mature spruce there were many young spruce. These young trees, combined with the poplars, constituted the mixed deciduous and coniferous forest. Occasionally, a large decaying pine was used as a drumming log provided that the vegetative features adjacent to this log were "acceptable" to the ruffed grouse. Palmer (1961) reported that three-quarters of the drumming logs which occurred in the Rifle River area of lower northern Michigan were white pines (*Pinus strobus*). These logs, evidence of a former mature white pine forest, were logged and/or burned. They compared with the mature spruce forest which existed in the Sheep River area of southwestern Alberta.

Drumming logs were the foci of the activity centres described by Gullion *et al*. (1962, p. 619). They described two kinds of activity centres: (1) a perennial centre which is occupied each season and (2) a transient centre which is occupied by one bird for its lifetime and then not occupied by another for several years, if ever again. They suggest that perennial activity centres offer an environment considered desirable by one grouse after another. Eng (1959, p. 100), on the other hand, suggests that "continued occupation of certain islands of favorable drumming habitat is largely due to a behavioral pattern or an association between individuals more than an inherent ability on the part of the bird to select favorable or unfavorable sites". Gullion *et al*. (1962) suggest that transient centres probably represent areas occupied by males during periods of population highs. Eng (1959, p. 100) shares this viewpoint. He states that "if newly occupied areas are not capable of securely maintaining a recruiting bird, except during periods of large numbers of reserves for replacement, it is thereby not apt to be continuously occupied. Thus, during years of low populations and low numbers of replacements, recruiting birds will more logically be present only in the more secure habitats". It appears, then, that the number of territories in use during the breeding season is dependent upon the number of male ruffed grouse available at that time. Those drumming sites which afford better protective cover for the grouse, thereby increasing their chances of survival, are most likely to be used continuously; whereas sites which do not

enhance the chances of survival will not be used continuously.

Palmer (1963, p. 601) sums up the complexity of factors which determine drumming site use. He says: "It does not appear that vegetation density is the only factor governing the choice of drumming sites. Apparently a combination of cover factors, such as juxtaposition of cover types, log placement in relation to *edge*, and even population density (social interaction?) govern selection".

DRUMMING ACTIVITY OF TERRITORIAL RUFFED GROUSE

Introduction

At the onset of the breeding season, drumming activity is very low. As the season progresses activity gradually increases, reaching a peak period lasting several days. Following the peak period, activity gradually decreases and finally ceases. The overall drumming activity cycle varies from one region to the next. Petraborg *et al.* (1953, p. 293) state that "the peak of drumming varies each year according to the time of the spring break up and it varies from south to north with a close correlation to the disappearance of the snow".

In addition to the seasonal cyclic pattern, drumming activity shows a daily cyclic pattern. Activity occurs mainly in the morning and evening. Petraborg *et al.* (*Ibid*) noted that morning activity of Minnesota ruffed grouse occurred between 04:00 and 11:00 hours with a peak between 05:00 and 06:00 hours; evening activity occurred between 16:00 and 20:00 hours with a peak about 17:00 hours. They suggest that,

during high population periods, drumming may occur sporadically during the day and night.

The second objective of this study was to measure the changes in drumming activity and to examine the relationship between this activity and abiotic and biotic factors.

Methods

Drumming activity was measured by recording the number of drumming sounds produced by a ruffed grouse during a 4-minute listening period. Recordings were taken at specified listening stations. These stations were at approximately one-half mile intervals along the forestry access road which was used as a transect. This transect began at the easternmost edge of the East area (mile 4-1/2) and ended at the westernmost edge of the West area (mile 12-1/2). There were seven stations on the East area and six on the West.

In 1964, only the number of drumming sounds was recorded. Runs were not conducted according to a specific pattern. They were started May 19 and ended June 11.

In 1965, drumming counts were started April 23 and ended June 5. These counts included a record of the number of sounds as well as the number of males which produced the sounds. At one station (mile 11 on the West area) activity was recorded from sunrise to sunset. The number of drumming sounds and the number of ruffed grouse responsible for these sounds were recorded during each 4-minute period. Fifteen periods were tallied, thus representing activity on an hourly basis.

The distances over which drumming sounds could be heard

were determined by following a barely audible sound to its source, or by gradually retreating from a sound until it was barely audible, and measuring the distance thus traversed. This procedure was executed in both densely and sparsely wooded areas.

In addition to drumming sounds, meteorological conditions were also recorded at each listening station along the transect. Light intensity was measured by pointing an Agfa Lucimeter or a Weston-Parker light meter towards the roadway. Light readings were a measure of reflected light from the surface of the roadbed. Light intensity was recorded at an ASA rating of one hundred; values were read from the EVS (Exposure Value Setting) scale. Air temperatures were recorded in degrees Centigrade. Wind velocity was measured in mph using a Casella portable anemometer. The anemometer, mounted on a tripod, was positioned approximately four feet above the ground. The number of revolutions recorded per 5 minute period was converted to mph using a Casella conversion chart. Thus,constant and gusting winds are included in the wind velocity data.

Results

Audibility of drumming sounds

Sounds travelling across open areas (i.e. canyons, meadows) carried farther than sounds travelling through densely wooded areas. Low-lying hills occurring between the drumming grouse and the recorder reduced the audibility of the sounds. In southwestern Alberta, distances over which drumming sounds could be heard varied from 1/8 to 1/4 of a mile. However,

most drumming sounds within 3/16 of a mile were detected.

Variation in drumming activity during the breeding season

The generally seasonal pattern of drumming activity which occurred on the East and West areas during the breeding season of 1965 is presented in Figures 10 and 11. Breaks in the graphs represent morning or evening when drumming counts were conducted. On these occasions weather conditions were inclement; for example, winds were stronger than 10 mph or snow or rain was falling.

Maximum activity in the morning occurred on May 4, but activity was generally high between May 1 and May 14. Maximum activity in the evening occurred on May 14, but activity was generally high between May 1 and May 14. On the whole, activity is greater in the morning than in the evening. Petraborg *et al* (1953) suggest that the windy conditions which often prevail during late afternoon and early evening may be the reason for lowered activity at this time.

Variation in drumming activity between days

The generally cyclic pattern of drumming activity over the breeding season is highly erratic, as shown in Figures 9 and 10. This erratic pattern, typical of the day to day variation in drumming activity, may be due to the influence of certain abiotic and biotic factors on territorial ruffed grouse.

Figure 10. Total number of drumming sounds produced by ruffed grouse per 4-minute period, A.M., along transect; April 23 to June 4, 1965.

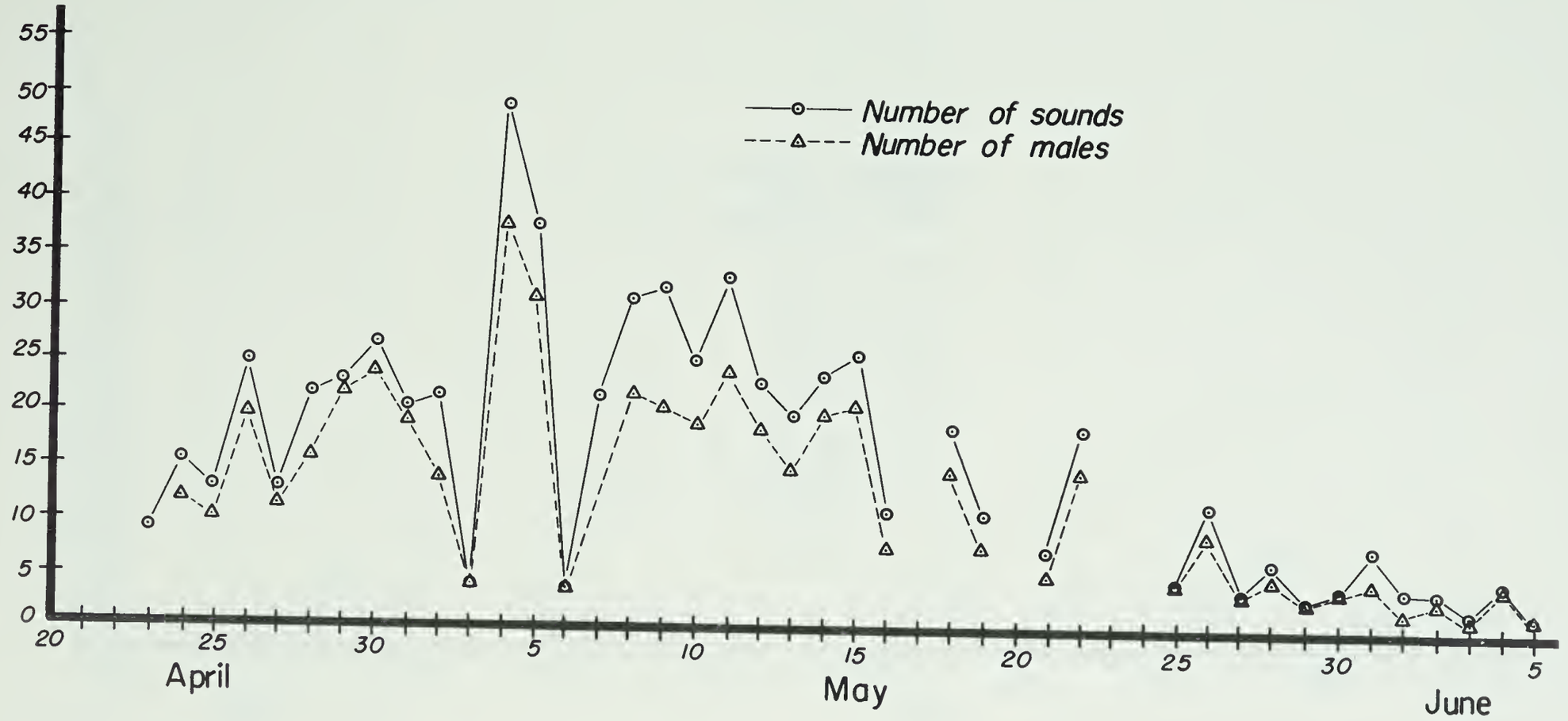
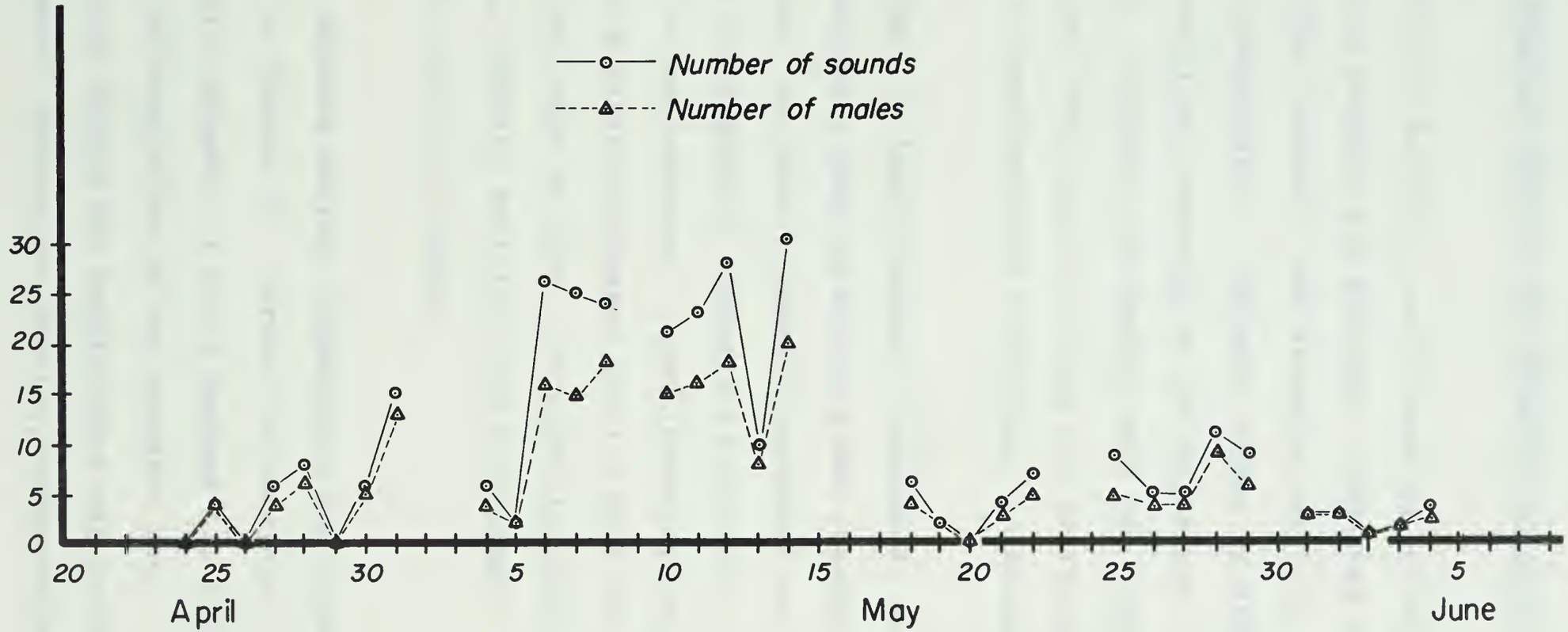
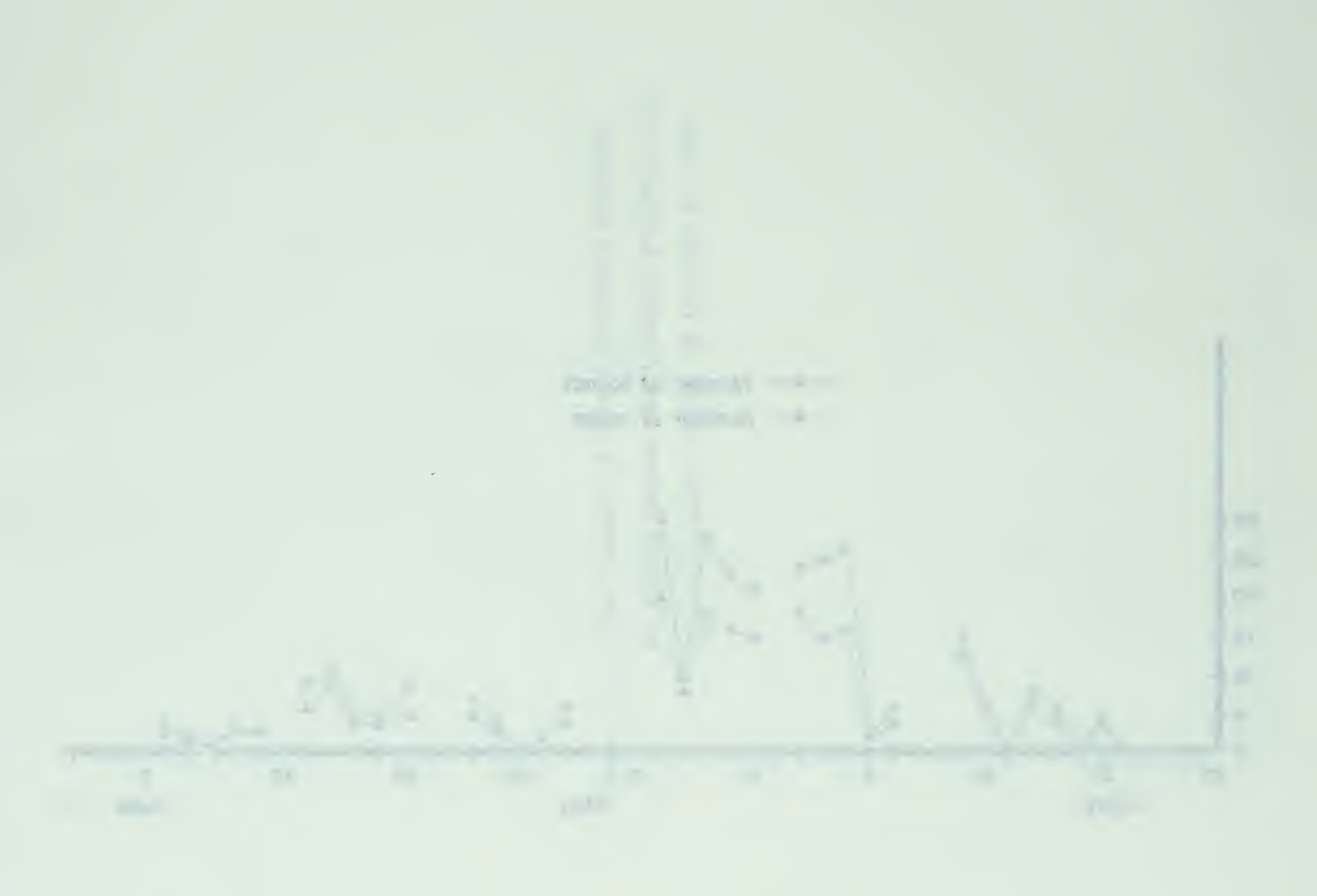

55
50
45
40
35
30
25
20
15
10
5
0
Number of sounds
Number of males
20
25
30
5
10
15
20
25
30
5
April
May
June

Figure 11. Total number of drumming sounds produced by ruffed grouse per 4-minute period, P.M., along transect; April 23 to June 4, 1965.


Number of sounds
Number of males
30
25
20
15
10
5
0
20
25
30
5
10
15
20
25
30
5
April
May
June



Relationship between abiotic factors and drumming activity

Light intensity

The diurnal pattern of activity, with drumming activity highest during the early morning and evenings, suggested a correlation between light intensity and drumming activity. This possibility was investigated. The mean number of drumming sounds recorded at each light intensity or EVS value are presented in Figure 12. Morning and evening data are separated. Light intensity readings less than four could not be recorded. Under these darkened or semi-darkened conditions, no drumming sounds were detected.

During the mornings, as light intensity increased, drumming activity also increased and a peak in activity was reached at an EVS value of nine. As light intensity continued to increase, there was a corresponding decrease in activity. The reverse occurred in the evenings. Light intensity decreased gradually and drumming activity increased until a peak was reached, again at an EVS value of nine. As light intensity continued to decrease, drumming activity also diminished. With complete darkness, activity ceased.

Temperature

The relationship between ambient temperature and drumming activity is presented in Figure 13. During the mornings, temperatures were usually between -1 to -5 degrees C., increasing to 8 to 12 degrees C. by completion of the transect run. Maximum drumming activity during the morning runs was recorded between 7 and 9 degrees C. During the evening, temperatures

Figure 12. Relationship between ruffed grouse drumming activity and light intensity in 1965. (Curves drawn by inspection)

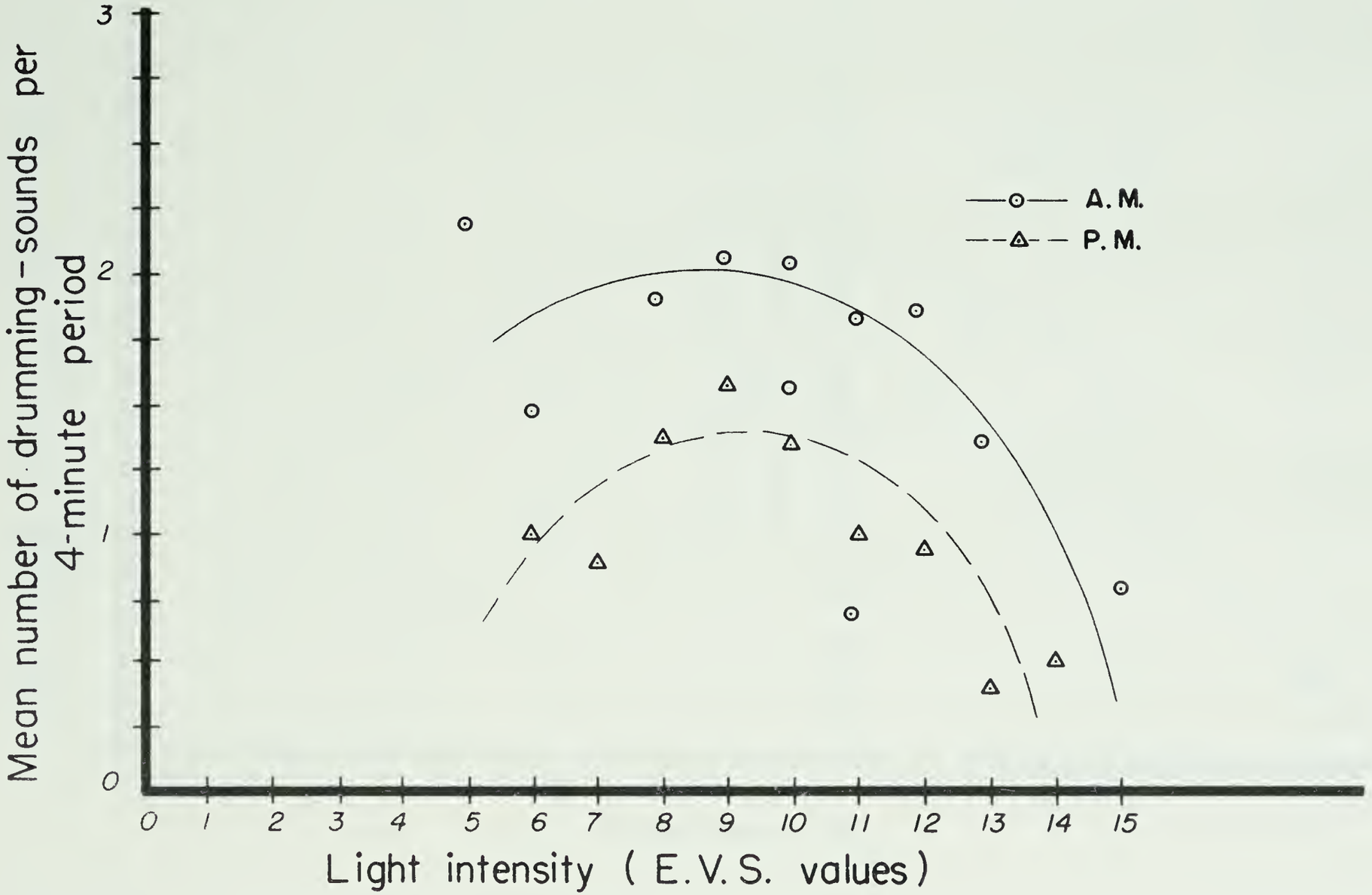
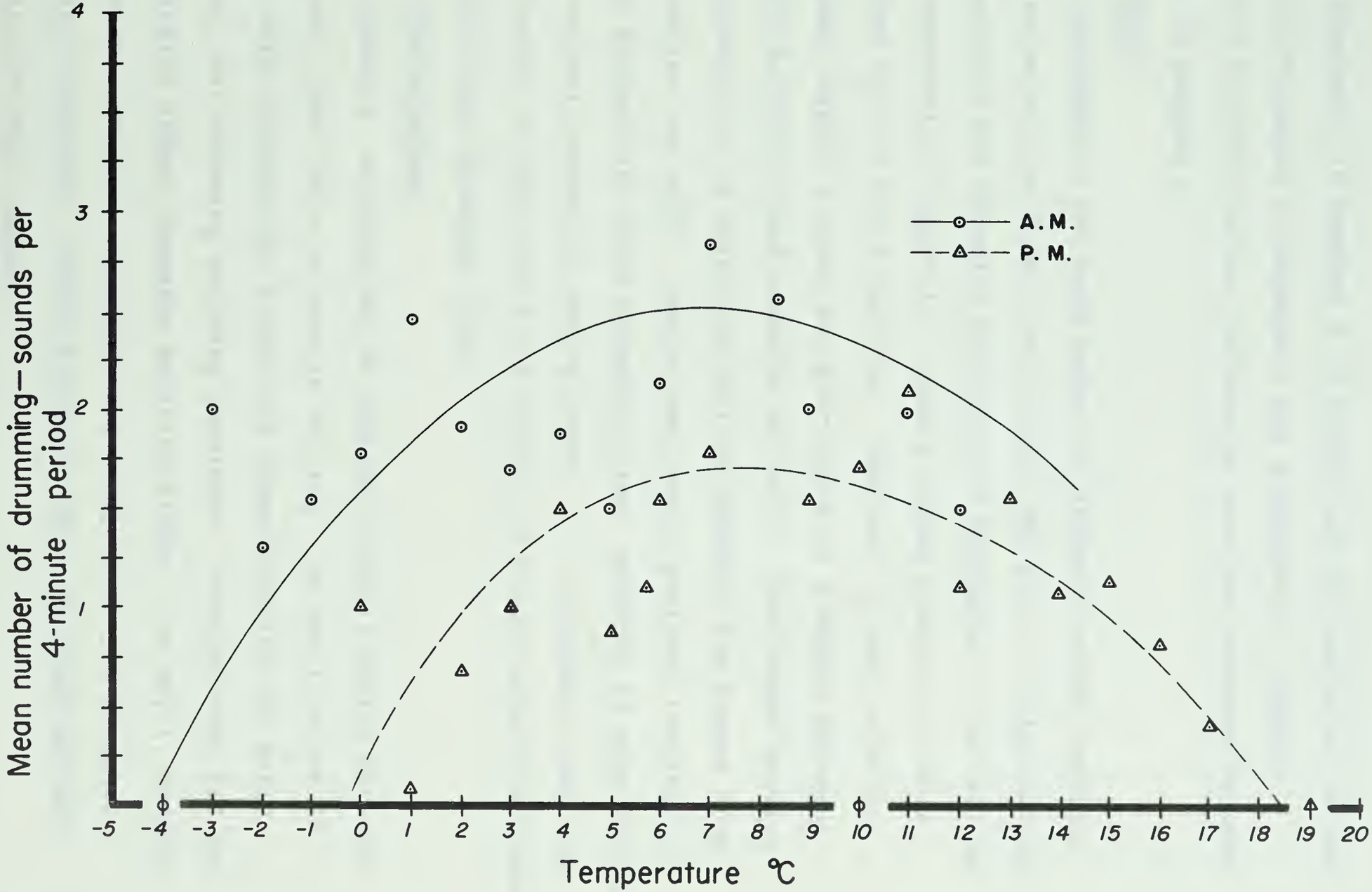

Mean number of drumming-sounds per 4-minute period
3
2
1
0
A. M.
P. M.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Light intensity (E.V.S. values)

Figure 13. Relationship between ruffed grouse drumming activity and temperature in 1965. (Curves drawn by inspection)


Mean number of drumming—sounds per 4-minute period
4
3
2
1
A. M.
P. M.
-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Temperature °C

were generally 15 degrees C or higher but by completion of the run had decreased to between 4 and 0 degrees C. Maximum drumming activity during the evening runs was recorded between 9 and 11 degrees C.

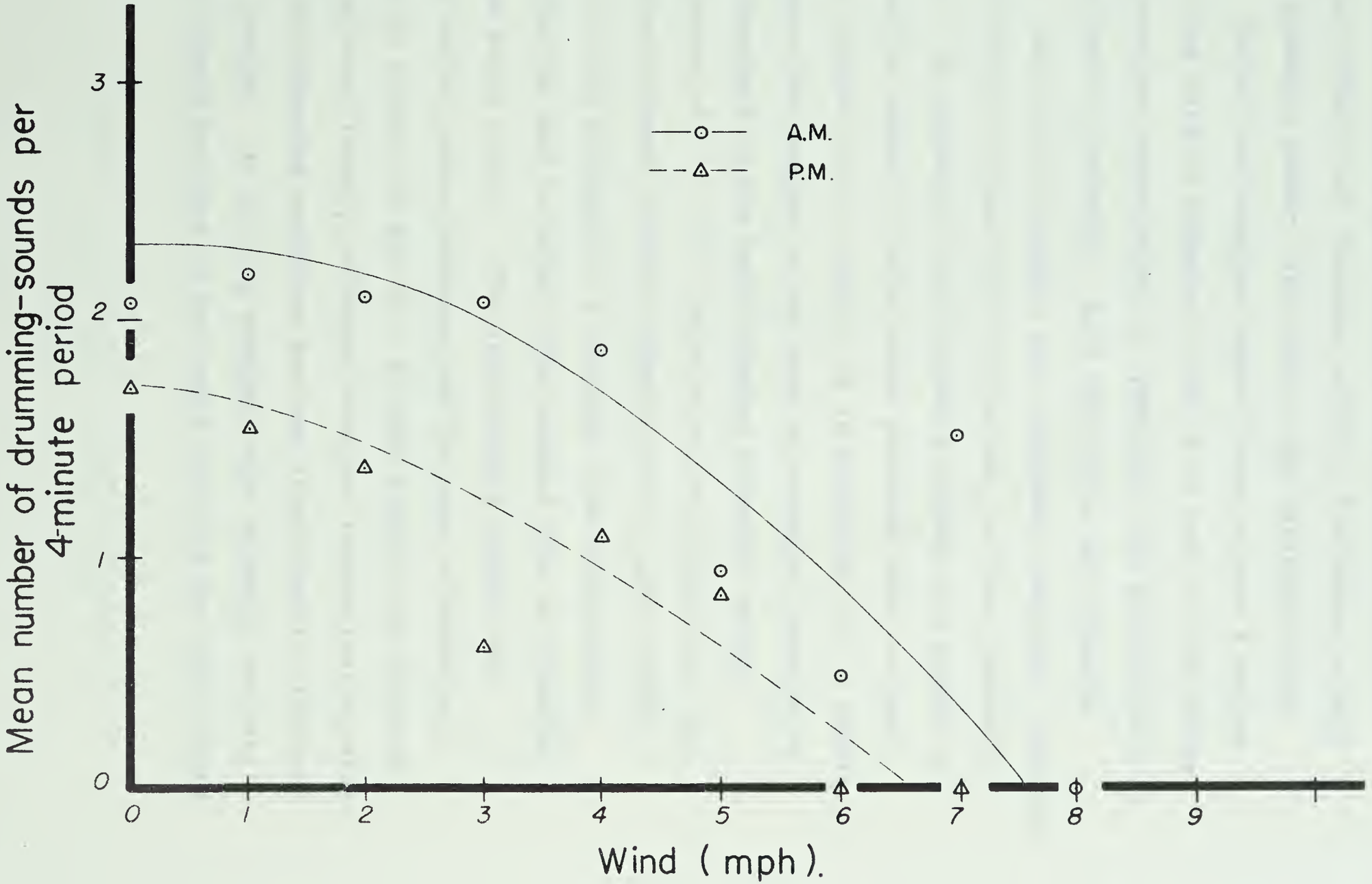
Wind

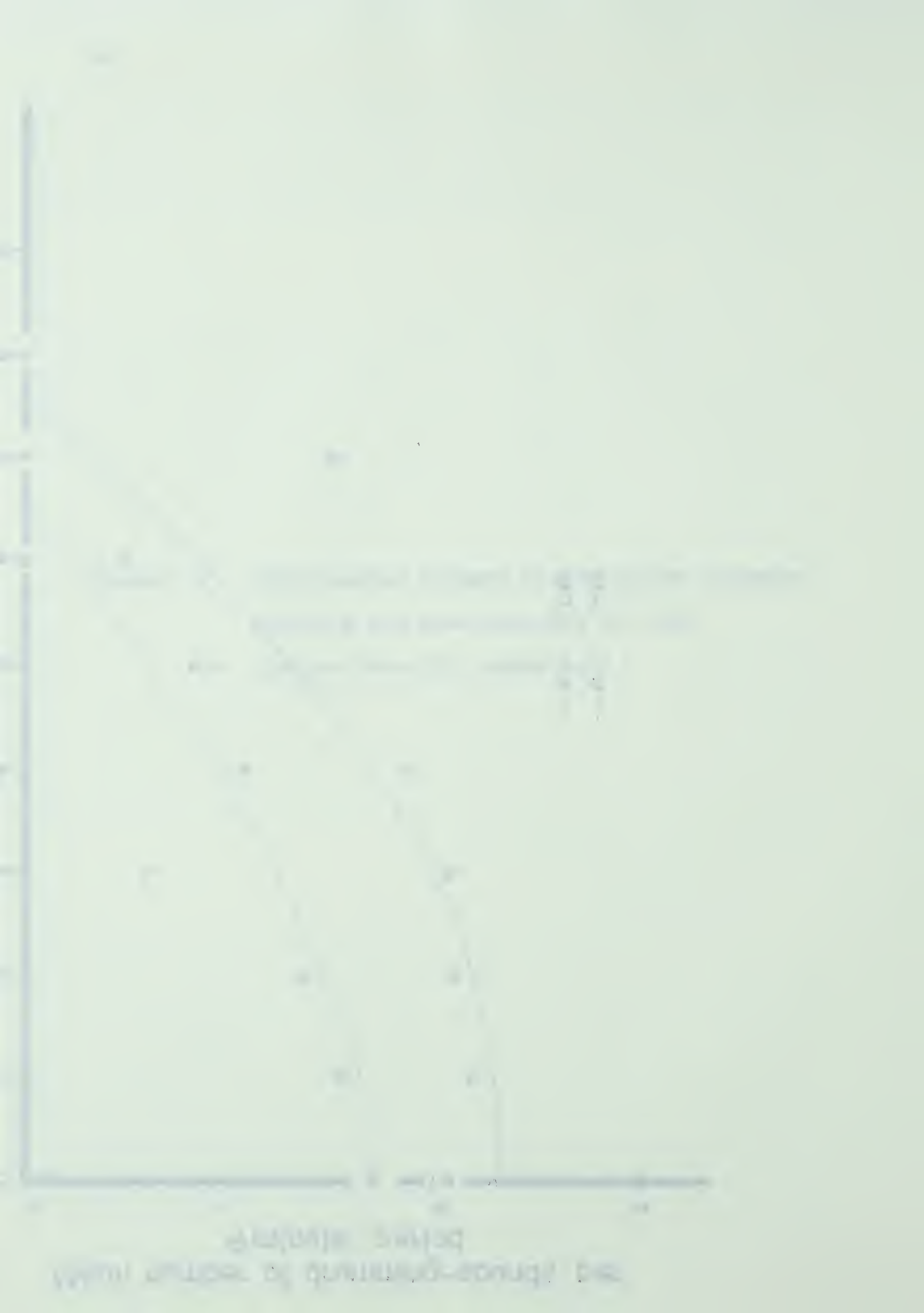
By comparing the mean number of drumming sounds recorded at wind velocities from 0 to 10 miles per hour, a relationship between wind and drumming activity was attempted. The results are presented in Figure 14. Ruffed grouse continue to drum in winds up to 4 miles per hour. However, if wind velocity increases beyond 4 miles per hour there is a marked decrease in both audibility and drumming activity. With winds gusting occasionally to 10 miles per hour or greater, the grouse drum only during the lulls. During very windy periods, territorial ruffed grouse left their drumming sites, probably to seek shelter in the small stands of spruce trees. It is probable that the combination of wind noises and swaying of trees caused the grouse to leave their drumming sites.

Precipitation

Drumming activity may be reduced slightly during periods when very light rain or snow is falling. On April 24 and 25 there were intermittent light rain showers during the early morning, yet drumming activity persisted. Settled snow did not drastically affect drumming activity either. On May 1, several inches of fresh snow blanketed the study area; yet drumming activity continued. During prolonged rainy or snowy periods drumming activity ceased.

Figure 14. Relationship between ruffed grouse drumming activity and wind velocity in 1965. (Curves drawn by inspection)


Mean number of drumming-sounds per 4-minute period
3
2
1
0
A.M.
P.M.
0
1
2
3
4
5
6
7
8
9
Wind (mph).



Relationship between biotic factors and drumming activity

It is evident that drumming activity fluctuates widely over the breeding season, with day to day variation often violent. During the breeding season there is also a marked change in the rate of drumming; that is to say, in the number of times one bird drums within a specified time period which in this case was four minutes. Like the day to day drumming activity, the rate of drumming also increased gradually, reaching a maximum during the peak activity period, and then gradually decreases. By comparing the difference between the number of sounds and the number of males which produced them, as presented in Figures 10, 11, and 15 to 18 inclusive, it is possible to determine the changes in the rate of drumming, both prior to and subsequent to the peak drumming intensity period.

Petraborg *et al* (*Ibid*) found that four minutes was the average time interval between drummings for a given ruffed grouse. On this assumption, a straight line relationship of Y = X can be used to depict this assumed rate of drumming, (i.e. once every 4 min.). The relationship between the number of ruffed grouse drumming and the rate of drumming is presented in Figures 19 and 20. In both figures the observed values are significantly different from the theoretical equation. However, the observed equations are not significantly different from one another. It is thus apparent that drumming activity increases beyond the rate of one sound per bird per four minute

Figure 15. Profile of ruffed grouse drumming activity on the morning of May 7, 1965.

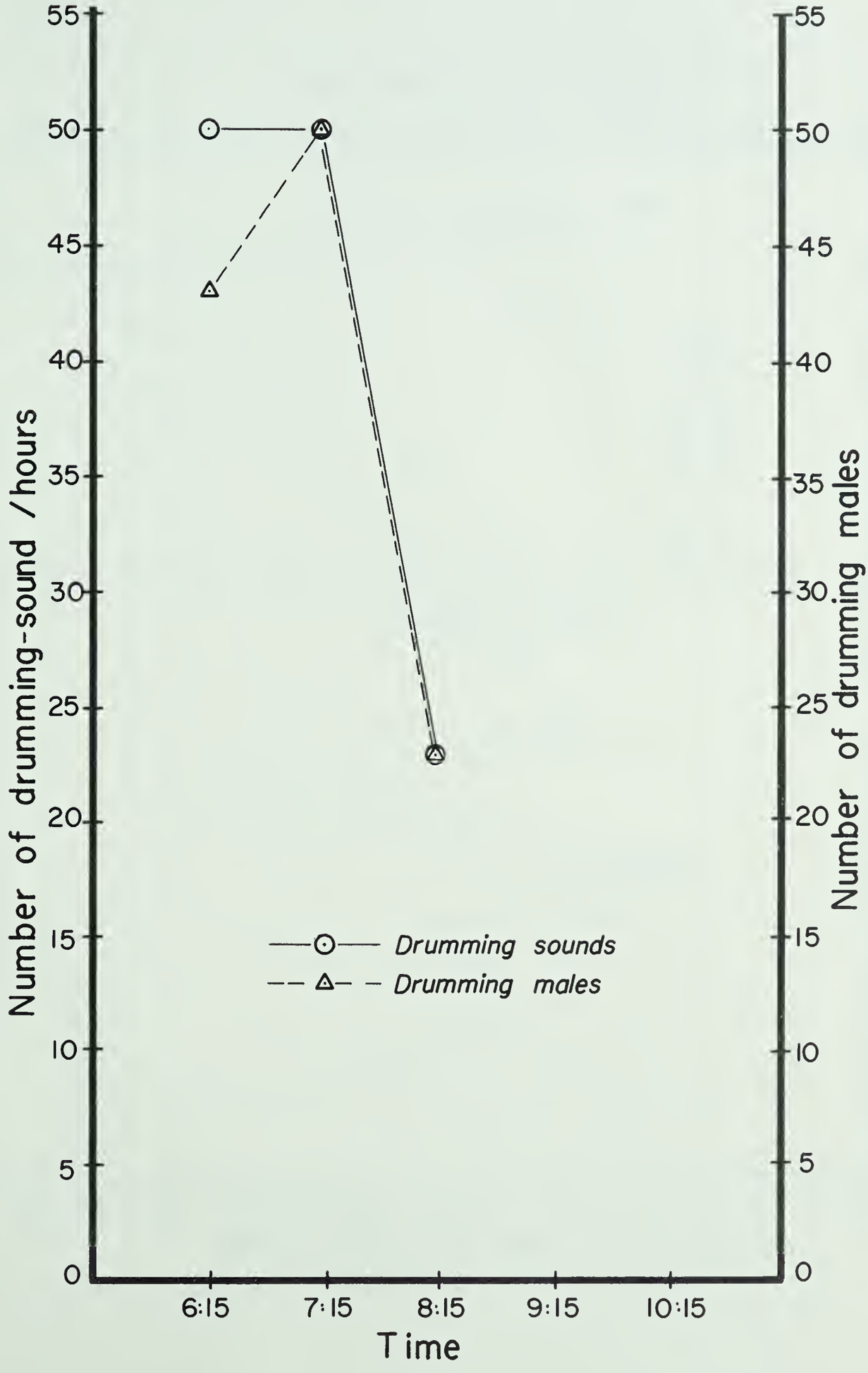

55
50
45
40
35
30
25
20
15
10
5
0
Number of drumming-sound /hours
Number of drumming males
Drumming sounds
Drumming males
6:15
7:15
8:15
9:15
10:15
Time

Figure 16. Profile of ruffed grouse drumming activity on May 8, 1965.

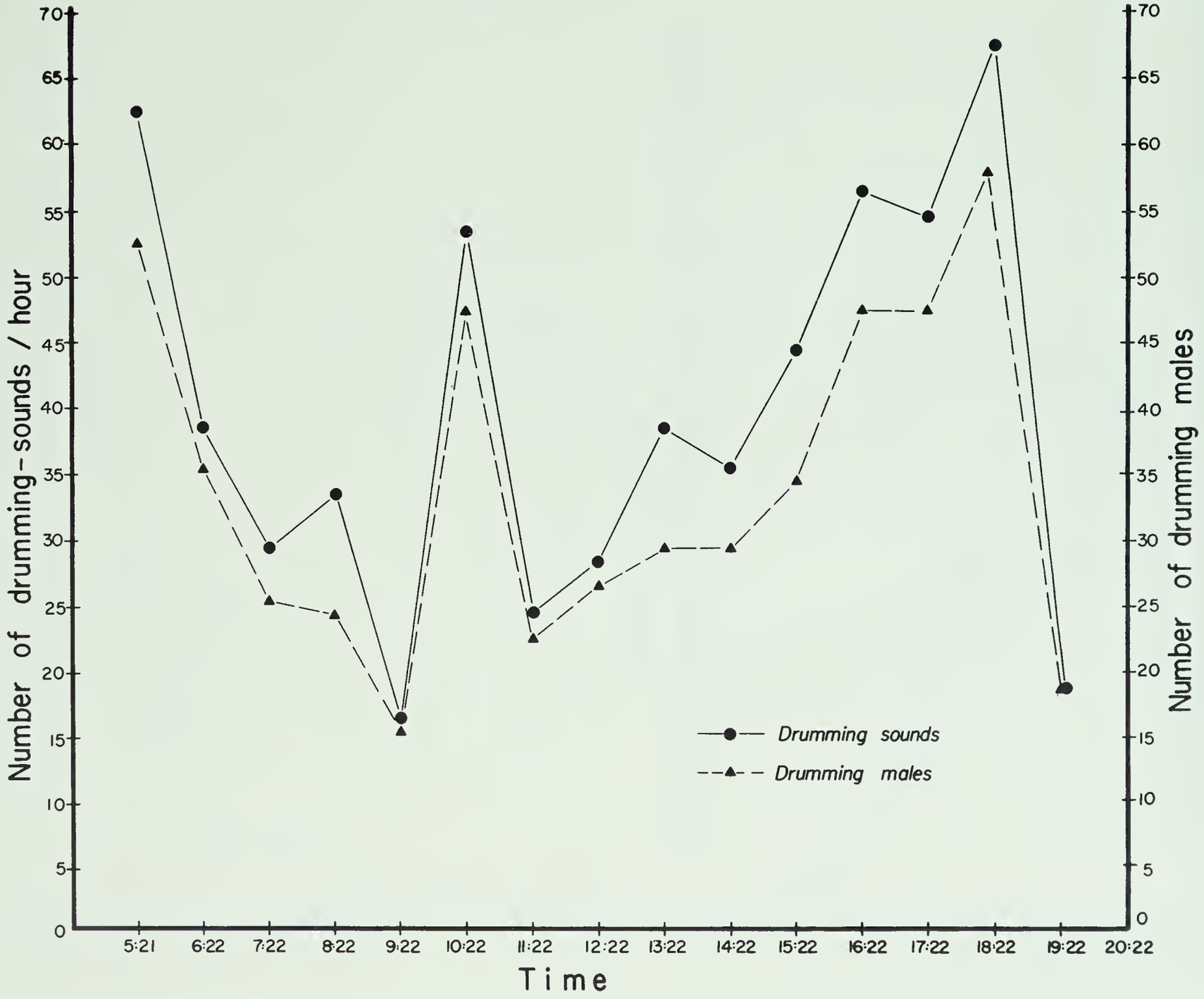

Number of drumming-sounds / hour
Number of drumming males
Time
Drumming sounds
Drumming males
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
5:21
6:22
7:22
8:22
9:22
10:22
11:22
12:22
13:22
14:22
15:22
16:22
17:22
18:22
19:22
20:22

Figure 17. Profile of ruffed grouse drumming activity on May 11, 1965.

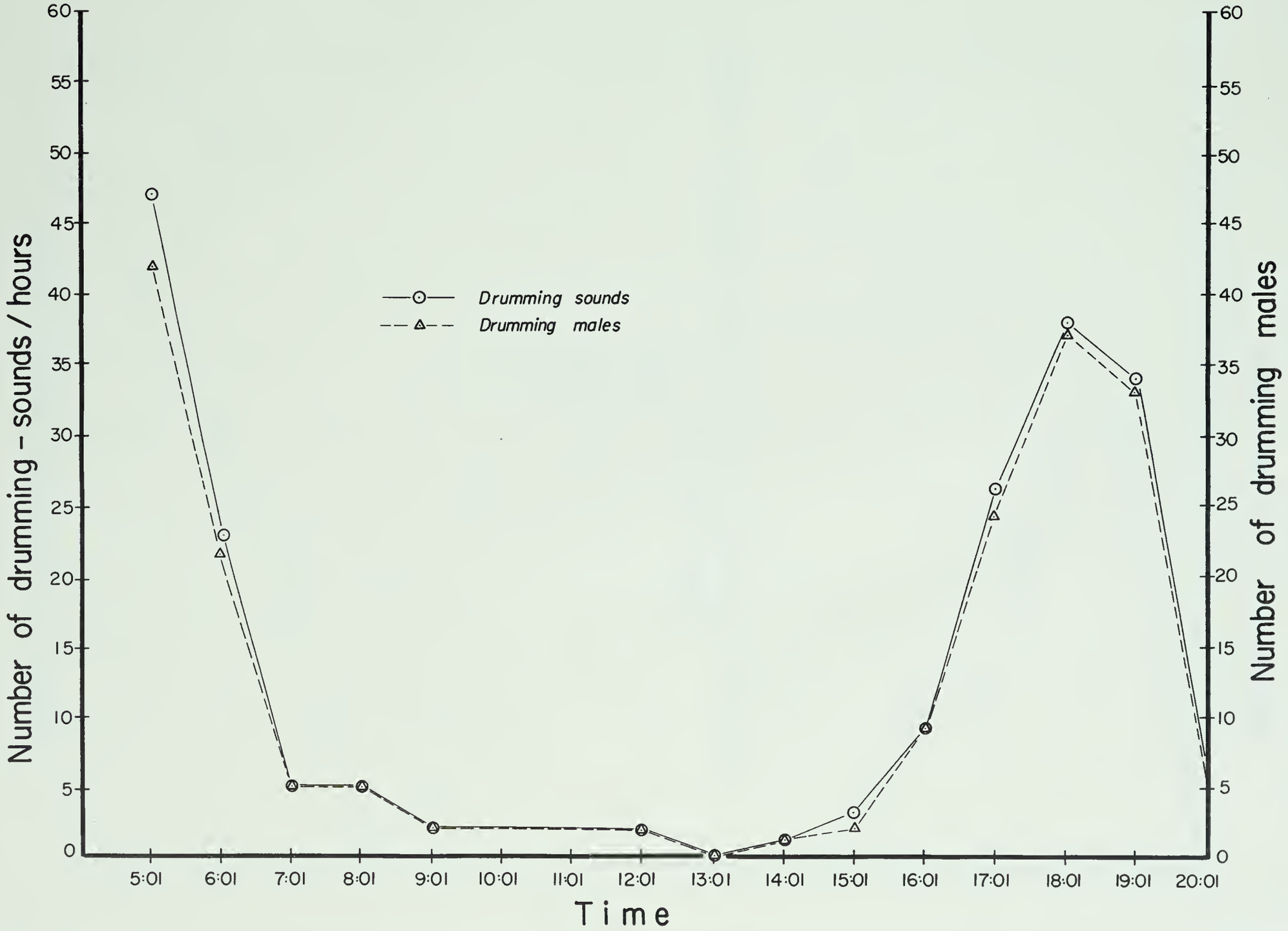

Drumming sounds
Drumming males
Number of drumming - sounds / hours
Number of drumming males
Time
0
5
10
15
20
25
30
35
40
45
50
55
60
5:01
6:01
7:01
8:01
9:01
10:01
11:01
12:01
13:01
14:01
15:01
16:01
17:01
18:01
19:01
20:01

Figure 18. Profile of ruffed grouse drumming activity on May 14, 1965.

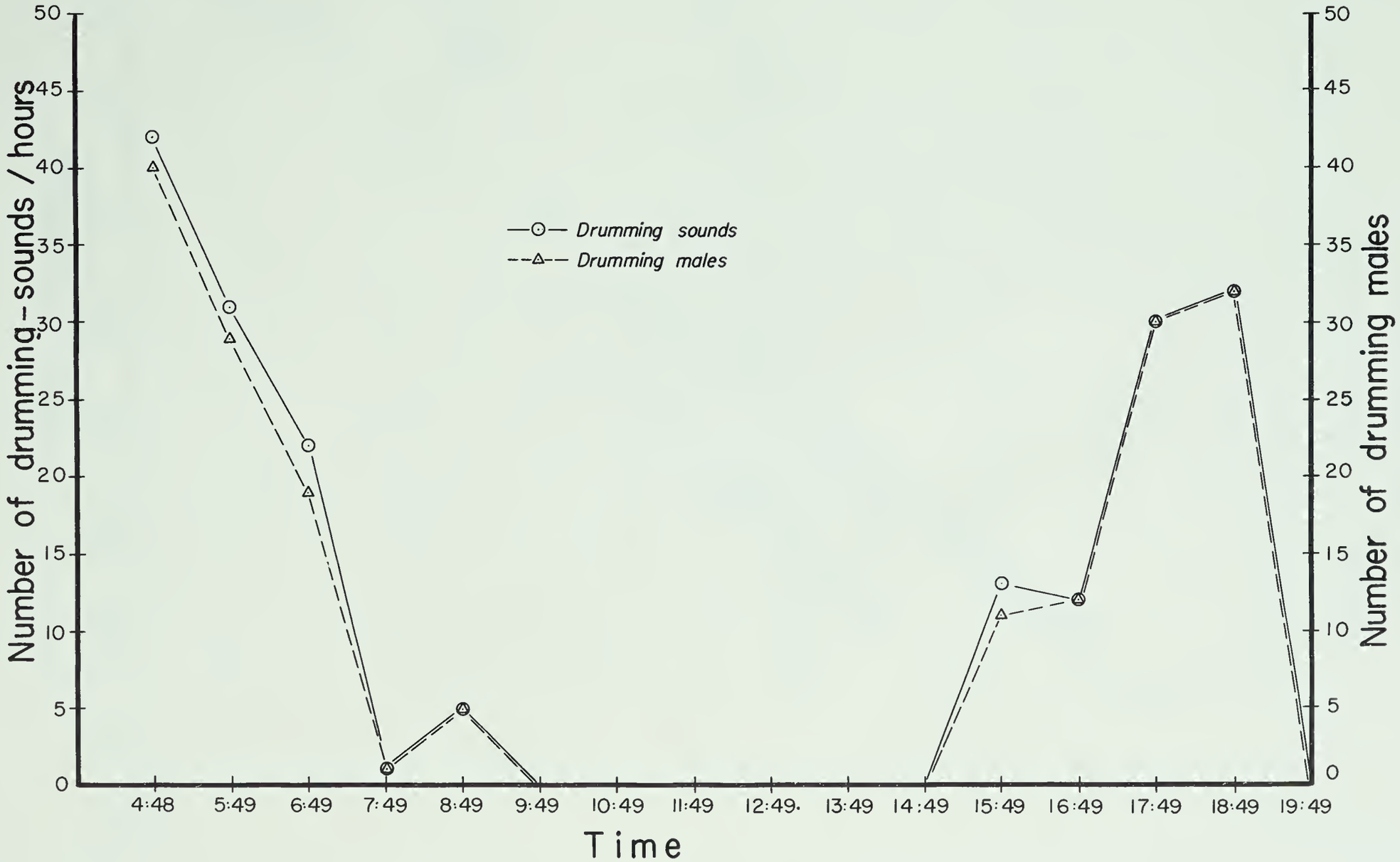

Number of drumming-sounds / hours
Number of drumming males
Drumming sounds
Drumming males
0
5
10
15
20
25
30
35
40
45
50
4:48
5:49
6:49
7:49
8:49
9:49
10:49
11:49
12:49.
13:49
14:49
15:49
16:49
17:49
18:49
19:49
Time

Figure 19. Relationship between the number of ruffed grouse drumming and the frequency of drumming based on data recorded during transect runs in 1965.

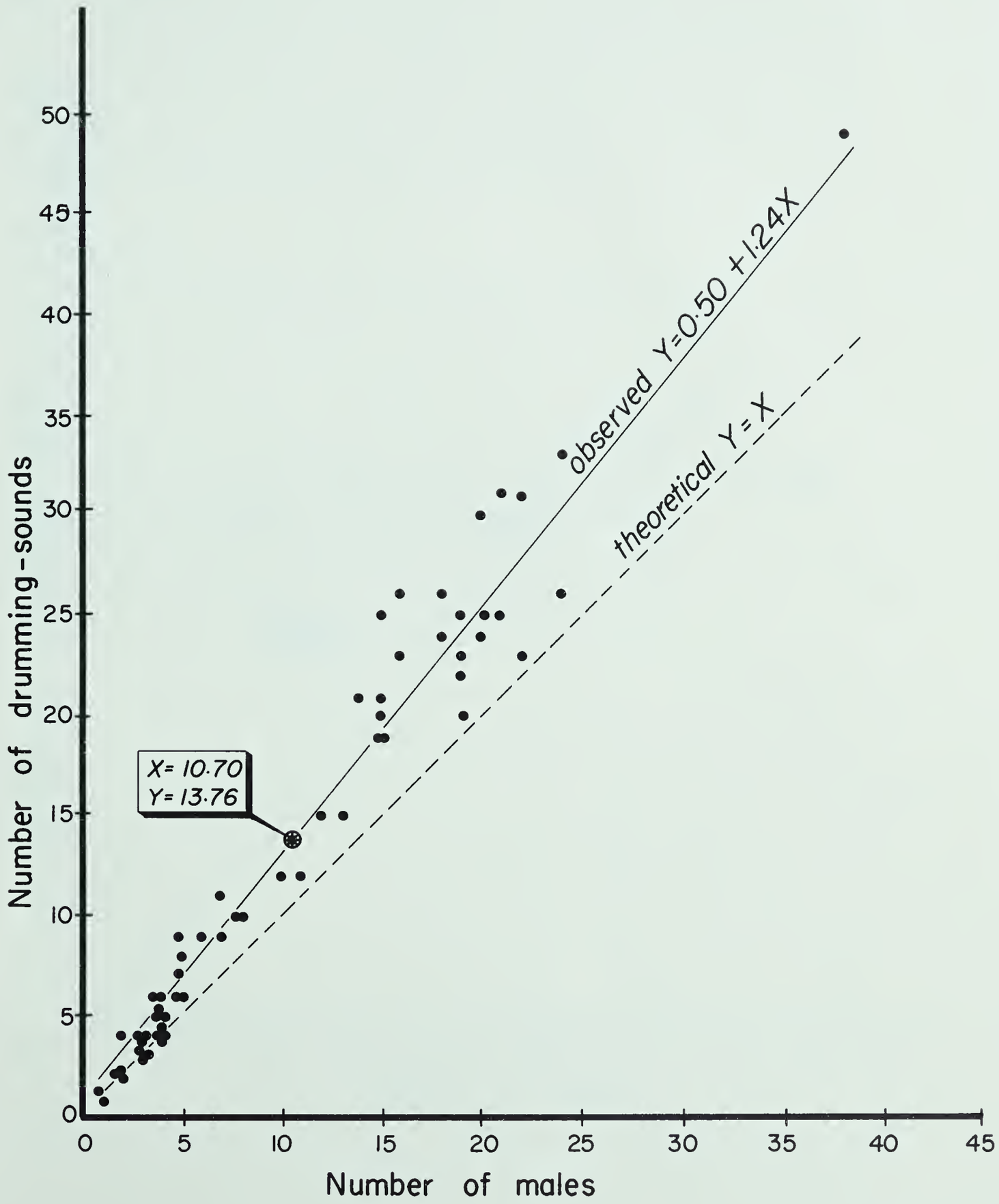
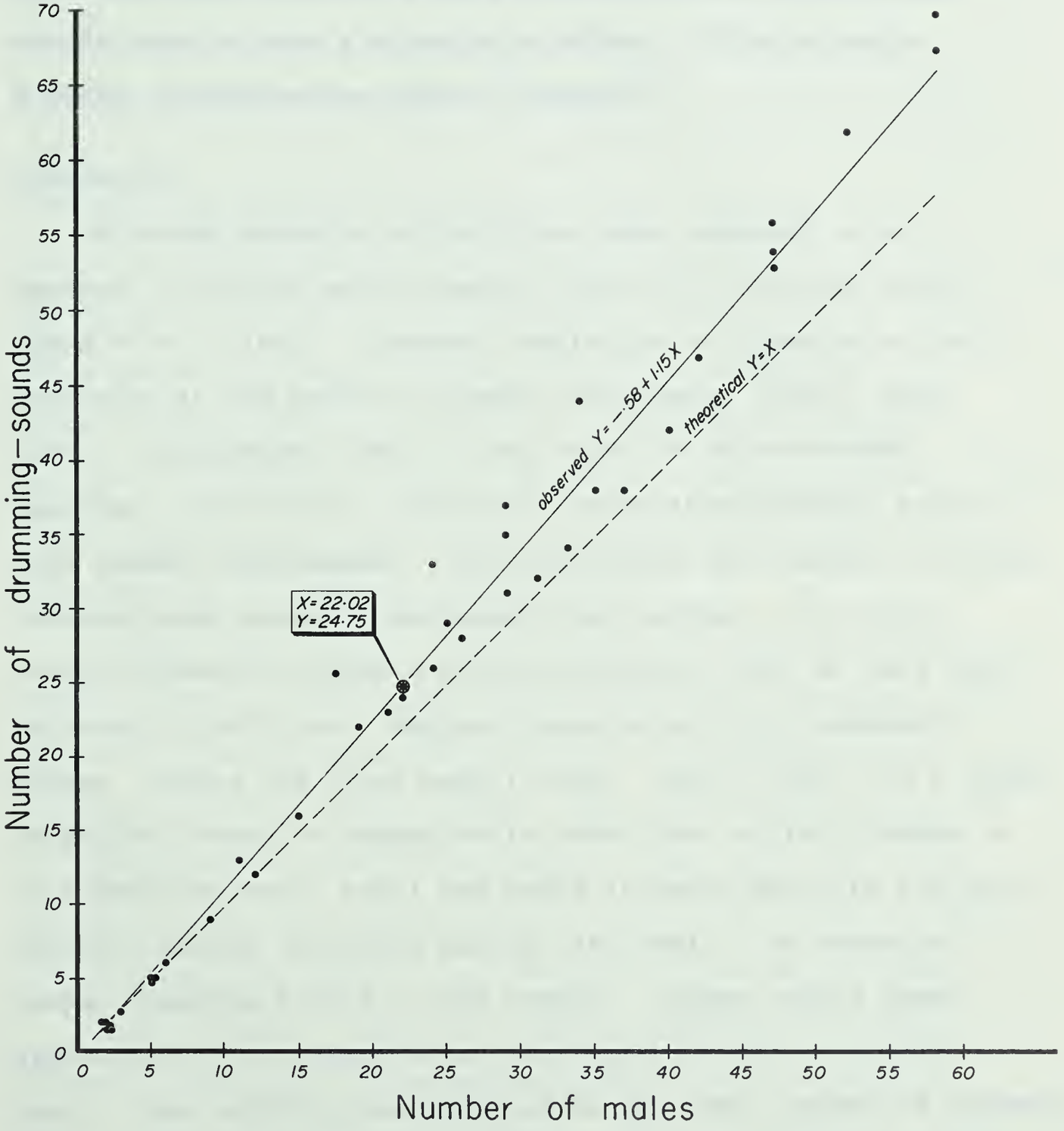

Number of drumming-sounds
Number of males
observed Y=0·50 +1·24X
theoretical Y=X
X= 10·70
Y= 13·76
0
5
10
15
20
25
30
35
40
45
50

Figure 20. Relationship between the number of ruffed grouse drumming and the frequency of drumming based on data recorded from sunrise to sunset at one listening stop in 1965.


Number of drumming—sounds
Number of males
observed Y = -.58 + 1.15X
theoretical Y = X
X = 22·02
Y = 24·75
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

interval and that this rate is maximum during the period of peak drumming activity (Figs 10, 11, and 16).

In areas where two (or more) territorial ruffed grouse can detect the drumming sounds produced by the other, the sounds seem to have a stimulating effect. This stimulus probably increases the rate of drumming.

Discussion

Although drumming activity has been recorded in all seasons, it occurs most commonly during the breeding season (Bump *et al.*, 1947). Seasonal variation in drumming activity occurring at the peak of gonadal development (Lewin, pers. comm.). Blanchard (1941) in her study of white-crowned sparrows (*Zonotrichia leucophrys*) correlated breeding activity with gonadal development. She discovered that maximum activity occurred when gonadal development was maximal. In south-western Alberta, drumming activity begins in mid or late April and ends by mid-June. Maximum drumming activity generally occurs during the first week in May. Davis (1951), in a study of ruffed grouse in Pennsylvania noted that activity began in late March or early April and ended in early May with the peak activity period occurring during late April. He conducted weekly drumming counts at one station. These counts began approximately two hours after sunrise and lasted one-half hour; thus activity was measured as the total number of drumming sounds heard per half hour. However, unless drumming activity is recorded daily, the period of maximum activity cannot be

determined accurately.

Abiotic, or physical factors, such as light intensity, temperature, wind and precipitation influence drumming activity. Light intensity and precipitation appear to have a greater influence on drumming activity than temperature and wind. Warrington-Williams and Stokes (1964), in a study of Chukar partridges (*Alectoris chukar*) in Utah, reported that physical factors accounted for 45 per cent of the variation in morning rally calling and 54 per cent of the variation in evening calling. They also found that, of the physical factors, light intensity and precipitation had the greatest effect on calling. In southwestern Alberta, precipitation and wind were responsible for most of the day to day variation in drumming activity, while light intensity and temperature were responsible for most of the variation in activity within a day.

Hjorth (pers. comm.), who studied the behavior of the black grouse also believes that environmental conditions have a marked effect on breeding activity. He suggests that breeding activity is often greater after a two or three day period of inclement weather than it is prior to such a period. The upsurge in activity, he believes, is due to a sudden release of "nervous energy" built up during the inclement weather.

Biotic factors may also influence drumming activity. Changes in the rate of drumming suggest that the drumming sounds may stimulate ruffed grouse. These changes vary from day to day and within days, and are maximum during the peak drumming activity period. Since the probability of an increase

in the rate of drumming is augmented by the presence of more than one territorial ruffed grouse, changes in the rate of drumming are partially dependent on the number of these grouse in a given area. Dorney (1958), expressing the density of territorial ruffed grouse as the number of males per 100 acres, did not find a significant difference in the ratio of drummings heard to the number of birds drumming during each four minute listening period at 15 listening stops. However, he does not exclude the possibility that changes in the rate of drumming may depend on the number of territorial ruffed grouse on a given area for he states (p. 38) that "the time interval between drummings is insensitive to density differences, at least at the levels worked with in this study". He suggests that variation in day to day activity may reflect differences in the behavior of individual males. These males he referred to as "silent drummers" since they did not drum during certain periods of the breeding season. He suggests that these silent periods may coincide with the receptive period of the female. I believe that territorial ruffed grouse consistently announce their presence during the breeding season by drumming and that the incidence of this activity is probably due to the combination of the degree of gonadal development and the stimulating effect of drumming sounds. Both of these factors seem to be modified by prevailing enviornmental conditions.

CENSUS METHODS FOR TERRITORIAL RUFFED GROUSE

Introduction

Several methods of estimating ruffed grouse populations have been developed. King (1937) devised a method referred to as the "King strip census". This technique involved walking along a transect or "strip" and recording the number of birds flushed. By extrapolation the number of ruffed grouse per unit area was determined.

Frank (1947) located all drumming sites within a given area and by assuming that each site represented one male ruffed grouse, he arrived at a male population density.

Petraborg *et al.* (1953) devised a method of determining the density of a male ruffed grouse population during the breeding season by using a "drumming census" technique. This method depended on the tally of drumming sounds heard within a one-eighth mile radius, per four minute period along a series of 10 listening stops or stations, one mile apart. The resulting male density was given as the number of males per square mile.

This technique has been used extensively by game managers because of the simplicity of application. The reliability of this technique has been examined by Dorney *et al.* (1958, pp. 38-39) who found that:

> "drumming counts provided an abundance index within reasonable limits of sampling error ... such drumming transects extended to other areas would likewise successfully estimate breeding season status of ruffed grouse cocks".

However, Petraborg *et al.* (1953) based the reliability of their

census on the assumption that a territorial ruffed grouse drummed an average of once every four minutes. Because of the variation in drumming rates this author questioned the reliability of the Petraborg method of estimating territorial ruffed grouse populations. Thus, another objective of this study was to test the reliability of the Petraborg method and to attempt to devise one which could be used in southwestern Alberta.

Methods

Census based on locating ruffed grouse territories

By locating all territories within a given area na accurate count can be made of the number of territorial ruffed grouse by equating one male grouse per territory. This method is referred to as the "direct-approach method".

Census based on the record of drumming activity

Using the drumming count data, it is possible to estimate the numbers of territorial ruffed grouse within a given area. For example, the maximum number of drumming sounds heard during the transect runs was recorded May 4, 1965. On the East area, 21 ruffed grouse produced 25 drumming sounds; on the West area, 17 ruffed grouse produced 24 drumming sounds. These birds represented the numbers of territorial ruffed grouse drumming within a three-sixteenth mile radius of each listening stop or station. Using the number of males, instead of the number of drumming sounds, it was possible to estimate the number of territorial ruffed grouse which occurred on the East and West areas. (See calculation)

Sample Calculation

$$\frac{N\ A}{(\Pi\ r^2\ S)\ (640)}$$ = number of territorial ruffed grouse for total area in acres

where: N = number of males producing the maximum number of drumming sounds

A = size of area in acres of the block through which the transect extends (i.e. size in acres of study area)

r = radius of audibility of drumming sounds (i.e. 3/16 of a mile)

S = number of stations along transect

Thus, $\frac{17 \times 608}{\Pi(3/16)^2\ (6)\ (640)}$ = 24.48 or 24 territorial ruffed grouse on West area (608 acres)

If the density of territorial male ruffed grouse is to be expressed as the number of male grouse per 100 acres then simply proportionate.

For example: $\frac{24.48 \times 100}{608}$ = 4.03 per 100 acres

Reliability of Census Techniques

The reliability of all census techniques used was checked by removing all territorial ruffed grouse from the West and Northwest areas. The ages of these birds were determined by using the method developed by Dorney and Holzer (1956). A method of determining the age of classes of ruffed grouse in Alberta, devised by Wishart (unpublished manuscript) was also used, in addition to the Dorney-Holzer method. The Wishart method is based on a measurement of the diameter of the first

(proximal) primary. This measurement is taken at the superior umbilicus, at approximately 90 degrees to the rachis.

Results

Territorial ruffed grouse census

The number of territories occupied and thus the number of territorial ruffed grouse which occurred on the study area is presented in Tables I and VII. From 1964 to 1965, there was no change in the number of territorial ruffed grouse on the West area. On the Northwest area, the number of territorial ruffed grouse increased during the two year period. In 1965, 15 territories were located on the East area. Two of these territories were on the south bank of the Sheep River and were not investigated.

Using the Petraborg method, the estimated number of territorial ruffed grouse in 1965 was 109 and 78 for the East and West areas respectively. Using the same method, but substituting three-sixteenths of a mile, instead of one-eighth as the radius of audibility, the estimated number of territorial ruffed grouse in 1965 was 50 and 34 for the East and West areas respectively. According to my method, the number of territorial ruffed grouse was estimated at 41 and 24, for the East and West areas respectively.

Removal of territorial ruffed grouse from the West and Northwest areas

Prior to the removal period, 71 trap nights yielded 18 captured territorial ruffed grouse. As several birds were

Table VII. Estimates of the Number of Territorial Ruffed Grouse on the Study Areas in 1964 and 1965.

Study Area	Number of occupied territories	Number of territorial ruffed grouse	
		Petraborg Method	Sumanik Method
East			
1964	no data	no data	no data
1965	15	109 (1/8)*	92 (1/8)
		50 (3/16)	41 (3/16)
West			
1964	24	35 (1/8)	no data
		49 (3/16)	
1965	24	77 (1/8)	55 (1/8)
		34 (3/16)	24 (3/16)
Northwest			
1964	3		
1965	5		

* numbers in parenthesis indicate the radius of audibility in miles used in Calculations.

trapped more than once, a total of 13 territorial ruffed grouse were mirror-trapped, marked and released.

Subsequent to the period of peak drumming activity, 26 territorial ruffed grouse were shot on the West area and four were shot on the Northwest area. The location of marking and subsequent killing are presented in Table VIII.

Fourteen males, or 47 per cent, were shot while on their drumming logs. Eleven males, or 37 per cent, were shot on or within their territories. The territorial status of five

unmarked males, 16 per cent, was unknown. Five males, or 16 per cent, were shot as reoccupants. Reoccupation occurred in three of the vacated territories. One territory was reoccupied successively by three different males and two others were reoccupied, each by a single male. The original occupants and all reoccupants were immature males. Two other males were killed near previously occupied territories. As they were not seen or heard drumming in these territories they were not regarded as true reoccupants.

Age-structure of the male ruffed grouse population

Figure 21 presents the age determinations of male ruffed grouse, using the shaft diameter of the first primary. Those males with a first primary shaft diameter of less than .091 inches were classed as immature; those with a first primary shaft diameter greater than .091 were classed as adults. The ratio of immature to adult males was 2.6 to 1.

Four females were collected. Using the same technique and a separation point of .085, two were found to be immature and two were adults.

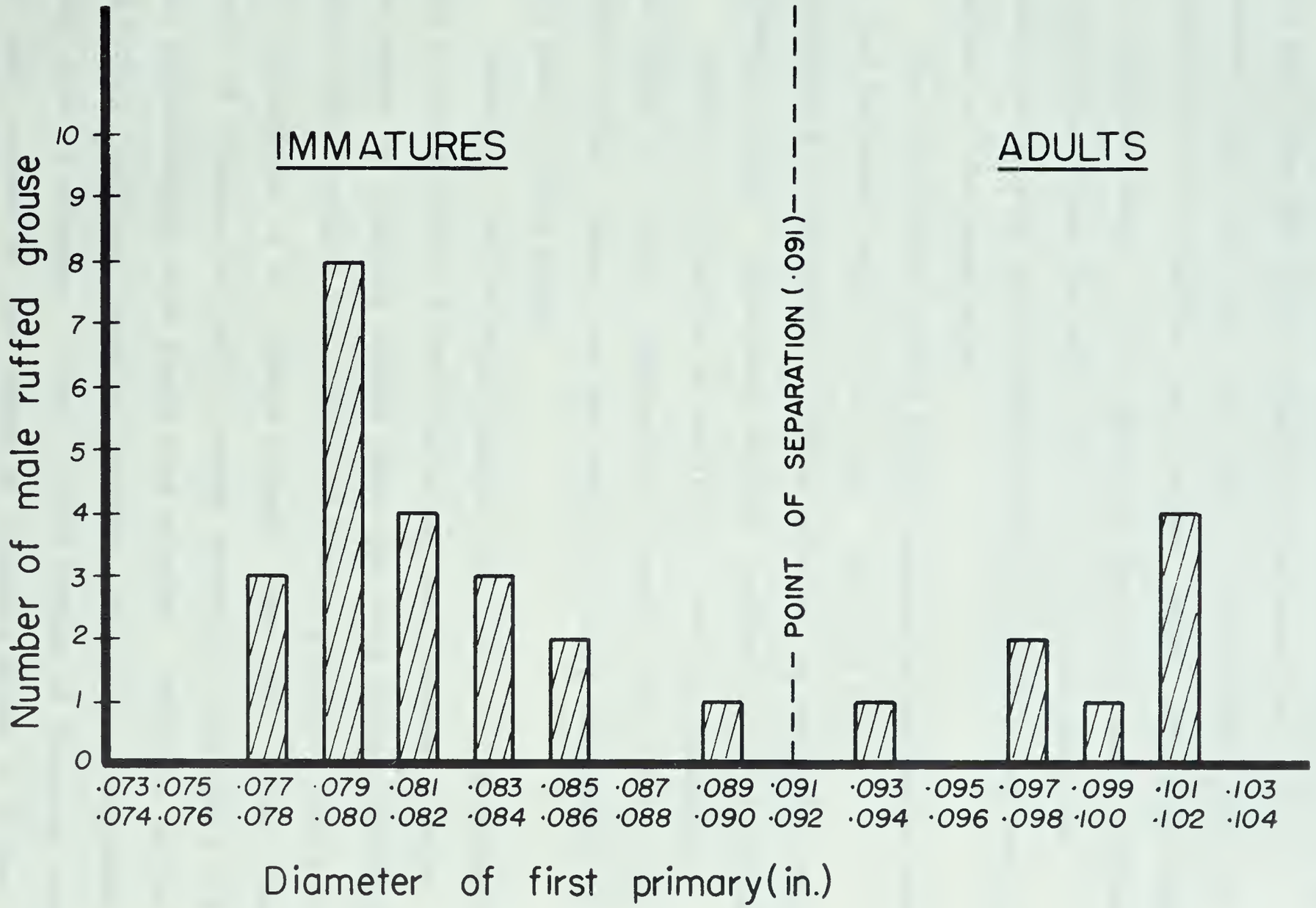
Discussion

Using both the direct approach method and the drumming count method, it was possible to determine the number of territorial ruffed grouse occurring on the study area. The former method is, however, impractical for determining the density of territorial ruffed grouse over a large area, as one must traverse, on foot, the entire area.

Table VIII. Banded and Unbanded Ruffed Grouse Males Removed From the West and Northwest Areas in 1965.

Banded or unbanded	Date banded	Date shot	Distance from site of capture
Banded	May 6	May 15	60 yds
Banded	May 5	May 15	100 yds
Banded	May 7	May 15	0 yds
Unbanded	-	May 15	-
Banded	May 7	May 15	150 yds
Banded	May 3	May 15	30 yds
Banded	May 4	May 15	150 yds
Banded	May 9	May 16	35 yds
Unbanded	-	May 16	-
Unbanded	-	May 17	-
Unbanded	-	May 17	-
Unbanded	-	May 17	-
Banded	May 3	May 18	0 yds
Banded	May 3	May 19	0 yds
Unbanded	-	May 19	-
Unbanded	-	May 19	-
Banded	May 2	May 19	0 yds
Unbanded	-	May 22	-
Banded	May 10	May 25	0 yds
Unbanded	-	May 25	-
Unbanded	-	May 25	-
Unbanded	-	May 25	-
Banded	May 5	May 26	0 yds
Banded	May 9	May 26	100 yds
Unbanded	-	May 26	-
Unbanded	-	May 31	-
Unbanded	-	May 31	-
Unbanded	-	June 4	-
Unbanded	-	June 10	-
Unbanded	-	June 14	-

Figure 21. Age composition of male ruffed grouse on West and Northwest areas, 1965.


IMMATURES
ADULTS
POINT OF SEPARATION (·091)
Number of male ruffed grouse
0
1
2
3
4
5
6
7
8
9
10
·073 ·074 ·075 ·076 ·077 ·078 ·079 ·080 ·081 ·082 ·083 ·084 ·085 ·086 ·087 ·088 ·089 ·090 ·091 ·092 ·093 ·094 ·095 ·096 ·097 ·098 ·099 ·100 ·101 ·102 ·103 ·104
Diameter of first primary (in.)

Occasionally, ruffed grouse could be heard drumming on the East area but their drumming sites were not located. Because these sites were not found, it was assumed that the grouse did not establish territories. Thus, they were regarded as transient males. It is possible that these males possessed territories along the outer edges of the study area and occasionally left their primary activity centers for auxilliary centers on the study area.

The territorial ruffed grouse population estimates based on the Petraborg method were high. They did not corroborate my estimates or those obtained by using the direct approach method. There were several reasons for this discrepancy.

Firstly, the radius of audibility used by Petrabord, one-eighth of a mile, resulted in a greater density of territorial ruffed grouse than the radius of three-sixteenths of a mile used in this study.

Secondly, the Petraborg method was based on the assumption that a ruffed grouse drums once every four minutes. Hence, the number of drumming sounds heard per four minute listening period would reflect the number of grouse producing these sounds. This assumption is not always correct (Fig. 20). During lower levels of drumming activity, ruffed grouse in this study did drum approximately once every four minutes. However, during the higher levels of drumming activity, the grouse increased their rate of drumming. Thus, if the number of drumming sounds was used, instead of the number of drumming males, a 25 per cent or greater overestimation would result. Because the

Petraborg method used the maximum number of drumming sounds, instead of the number of males producing these sounds, estimates of the number of territorial ruffed grouse were too high.

Other possible errors could have affected the accuracy of the territorial ruffed grouse estimate. According to Dorney *et al*. (1958), errors could result from: (1) a difference in the percentage of males that drum; (2) a variation in the time interval between drumming; and (3) differences in the density of the territorial ruffed grouse population. Because Dorney *et al*. (*Ibid*), did not conduct transect runs daily, they were never certain that they had determined the peak drumming activity period. They conducted two or three transect runs and used the highest recording, assuming that it represented the peak drumming activity period. Because of the violent fluctuations in drumming activity, I believe that they were not justified in making this assumption.

There were several reasons for the differences in the number of territorial ruffed grouse on the East and West areas in 1965. On the East area, territorial ruffed grouse occurred in scattered patches of mixed forest, consequently the grouse were not dispersed uniformly. The calculation of territorial ruffed grouse density depends on extrapolating from a sample area, where the number of grouse is known, to an area where the number is not known. The more uniform the dispersion, the more reliable is the extrapolation. By coincidence, all but one station along the East transect run was adjacent to areas

where territorial ruffed grouse occurred. Most of the surrounding area consisted of unsuitable ruffed grouse habitat. Consequently, the extrapolation from the sample area where the grouse did occur to the greater area where they did not occur, resulted in an abnormally high territorial ruffed grouse population estimate.

There was an apparent difference between the number of territorial ruffed grouse on the East and West areas, in 1965. On the West area, the number of birds remained relatively stable during the breeding season, but on the East area, their numbers increased rapidly from 15 to 22 by May 4, then decreased rapidly to 13. Of the 22 ruffed grouse on this area which produced the high drumming count of 25, 7 failed to establish territories for the whole season. The fate of these males is unknown. It is possible that these transients represented a reservoir of male ruffed grouse as described by Eng (1959).

In order to census accurately territorial male ruffed grouse, it is necessary to determine (1) the peak of drumming activity; (2) the number of ruffed grouse producing the maximum drumming count; (3) the radius of audibility of the sounds; and (4) the nature of the dispersion of the territorial ruffed grouse.

The number of territorial ruffed grouse shot on the West and Northwest areas closely approximated the population estimate by my technique and hence it was considered a suitable means of estimating the number of male ruffed grouse on the study areas.

Following a similar "shoot-out" experiment in Wisconsin, Dorney and Holzer (1956) reported an immature male to adult male ruffed grouse ratio of 16:39. In this study, more immature males occurred on the West and Northwest areas than did adults. The predominance of immature ruffed grouse males suggests that overwinter survival was high.

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